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ELECTRIC TRACTION for the New York elevated railways is again being talked of, and Mr. Russell Sage is quoted as stating that negotiations have been pending for some time for the sale of bonds to the amount of $8,000,000 or $10,000,000 for this purpose. He is also credited with the statement that this decision has been made largely upon the favorable report made by the General Manager, Mr. Fransioli, upon the Chicago electric elevated railways. The Second Ave. line would be the first to be equipped for electric traction. No definite action has yet been taken on this question.

A COMBINATION OF ALL THE ELECTRIC AND ELEvated railways of Brooklyn, N. Y., is regarded as a possibility in view of the proposal to adopt electric traction on the elevated lines. A conference of representatives of all the companies was held last week, at which figures were presented to show the economy in cost of operation which would result from such a step. The difficult points to be settled are the division of the receipts, and the method of effecting the combination. The latter may be by the formation of a pooling arrangement, or by a lease of all the roads to one of the companies.

AN ELEVATED RAILWAY FOR ELECTRIC CARS is proposed at Jersey City, N. J., to relieve the traffic on Grand St., where all the traffic converges for the Pennsylvania R. R. ferries to New York. It would leave the street clear for vehicles and allow of much greater speed of the cars, thus shortening the time of transit to and from the numerous suburban points.

THE TRACK IN THE BOSTON SUBWAY will consist of 85-lb. rails of the Am. Soc. C. E. section, spliced with the Continuous rail joint, and laid on treated chestnut ties in broken stone ballast.

THE CABLE RAILWAY CURVE at 14th St. and Broadway, New York city, where so many accidents have been caused by the high speed of the cars, is a subject of discussion by the city authorities. The railway company proposed to eliminate the curve by a tunnel under Union Square, but the approaches would destroy a considerable amount of the Park. Mr. McMillan, President of the Park Board, suggests a practically straight line on the surface by giving up a portion of the west side of the Union Square Park.

ANOTHER EAST RIVER TUNNEL project is now being put forward by the New York & Brooklyn Tunnel Co., 35 Broadway, New York city. The proposed route is from the junction of Court and Montague St., in Brooklyn, to a station under the Equitable Insurance Building, on Broadway, New York. Mr. Herman C. Hilmers is President of the company.

THE TEHUANTEPEC RAILWAY, according to press dispatch from Mexico, is made the subject of a formal offer of purchase from the Mexican government by an American syndicate, headed by Mr. C. P. Huntington. A similar offer was made two years ago and refused, but the road is said to have since proved a losing venture, so far as net earnings are concerned, and the government has referred the offer to a special commission with power to act for the government. It is believed that the offer will be accepted and the line will then be operated in connection with the Pacific Mail steamships.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision Feb. 22, at Ebensburg, Pa., on the Pennsylvania R. R., between a mail train and a freight car which had fouled the main track. Six persons were badly hurt. It is said that boys had been moving the cars on the side track in play.

EXPLOSIONS OF NATURAL GAS occurred Feb. 20 in the engine room of the "Chicago Chronicle," Chicago, Ill., owing to leaks in the pipes from the street mains. There was a series of explosions, which did considerable damage and set fire to the building, but the firemen soon got it under control.

THE OHIO RIVER IMPROVEMENTS, including four dams and locks below Pittsburg, are postponed owing to an insufficiency of appropriation by Congress. The work contemplated was to cost about $2,000,000 and a cash appropriation of only $30,000 was made. The Chief of Engineers, Gen. Wilson, has ruled that in a similar case in California, the work cannot be commenced. The law on the subject provides that—"No contract shall be entered into for any public improvement which shall bind the Government to pay a larger sum of money than the amount in the Treasury appropriated for that specific purpose." Each of the four proposed dams would cost $650,000, according to the estimates of Col. Amos Stickney, Corps of Engineers, U. S. A.

THE EXTENSION OF THE NEW YORK PIER LINE was opposed by the opposite New Jersey interests before the Board of Engineers and Harbor Line, presided over by Col. Henry M. Roberts, Corps of Engineers, U. S. A. The Riparian Commission of New Jersey, through its attorney, contended that the same extension had been denied to Hoboken in 1890 by a board of U. S. engineers, and the same arguments then used were equally in force in regard to the New York side of the North River. The New York interests all favored the extension, and it was hinted that the opposition came from steamship owners having docks at Hoboken, who feared a loss of business were superior accommodations provided on the other side of the river.

THE PASS A L'OUTRE CREVASSE, in the Mississippi delta, is to be closed by the government and the Senate Committee has agreed to the House appropriation of $250,000 for this purpose, with some amendments. As agreed to, the bill appropriates the money, but it holds intact the rights of the United States under the Eads contract and does not release the Eads estate from any obligations under that contract. The question of the obligation of the Eads estate to close this crevasse is referred to the Attorney-General, and if he shall decide against the estate, the amount actually expended in repairs is to be deducted in the final settlement with the estate. As lately mentioned in this journal the defense of the Eads representatives is that the contract was based upon normal conditions, and this crevasse was an "act of God," for which the estate can not be held liable.

SUEZ CANAL BUSINESS FOR 1896 was the most remunerative on record; the traffic aggregated $15,930,435, says U. S. Consul General Penfield, of Cairo. England supplied two-thirds of this traffic. The total number of steamers passing through the canal in 1896 was 3,407, with an aggregate tonnage of 8,594,307. The receipts were abnormally increased by the number of Italian soldiers going to and returning from the Abyssinian war. Not a single ship carrying the American flag passed through the canal last year.

THE ERIE CANAL IMPROVEMENTS are to be carried on vigorously, and a bill has been introduced in the New York state legislature to appropriate $5,000,000 to continue the work, this sum being the balance of the $9,000,000 authorized to be expended for this purpose.

THE PASSAIC DRAINAGE COMMISSION, appointed last spring to investigate means for preventing the pollution of the Passaic River, has just submitted its report to the New Jersey legislature. It recommends that a commission be established to construct an intercepting sewer along the Passaic River and to have in charge the protection of the upper reaches of the river. The expense of the proposed work would be apportioned among the communities benefited. The commissioners were: Messrs. W. T. Hunt, and H. C. Herold, M. D., of Newark, and Elias J. Marsh, M. D., of Paterson. Messrs. A. Fteley, M. Am. Soc. C. E., and Chas. E. A. Jacobsen were engineers to the commission. Mr. Jacobsen died on Feb. 11, as noted in our issue of Feb. 18.

A RESERVOIR FOR RAILWAY WATER SUPPLY is to be established near Lineville, Ia., by the Chicago, Rock Island & Pacific Ry., owing to the difficulty in obtaining water on the 40 miles between Seymour and Purinton, Mo. At present, it is said, trains are frequently sidetracked while the engines run 12 or 15 miles to a water station.

THE FOREST RESERVES of the United States have been increased by the withdrawal from settlement of 13 forest tracts aggregating 21,379,840 acres. This has been effected by proclamations signed by President Cleveland on Feb. 22. The forest lands selected for preservation were chosen by a commission of six experts, appointed over a year ago, at the request of Mr. Smith, Secretary of the Department of the Interior, by the National Academy of Sciences. Prof. Sargent, of Harvard University, was chosen President of the commission, and the other members were Prof. Brewer, of Yale; Alexander Agassiz, Gen. Abbott, U.S.A. (retired); Evan Pinchot, of New York, and Arnold Hague, of the U. S. Geological Survey. The new reserves are in South Dakota, Wyoming, Montana, Idaho, Washington, Utah and California.

A LARGE WATER POWER SCHEME is projected by the Southern California Power Co., of Redlands, Cal., which has been organized with a capital stock of $1,000,000. The plan is to develop power from the Santa Ana River by taking the water out at the junction of Bear Creek and Santa Ana River, carrying it in a cement ditch and tunnels about four miles, thus securing a fall of 1,000 to 1,100 ft., and then running the water again into the stream. The power will be transmitted by pole line 75 miles to Los Angeles, and this is to be the longest line and to carry the highest voltage (30,000 volts) in the world. The line will run through San Bernardino, Pomona, Ontario and Pasadena, and will be able to supply all power needed in these towns. Reports state that work will be begun in the Santa Ana canon as soon as the surveys are completed, which will be about April 1. It is proposed to deliver power in Los Angeles by January, 1898. Mr. Henry Fisher, of Pittsburg, Pa., is president of the company.

"FOREIGN AND IMPORTED CEMENTS" may no longer be specified by the several departments, bureaus and commissions of Philadelphia, in asking proposals for work requiring Portland cement. The committee on municipal government has approved and recommends the passage of an ordinance recognizing the merits of the American Portland cements and requiring that, in advertising for proposals for cement, the requisite strength and fineness for the work proposed shall alone be specified.

THE PURCHASE OF TWO DELEHANTY SELF-dumping scows has been authorized for the use of the New York Street Cleaning Department. The boats are to cost not over $40,000 each and Lieut. Delehanty is to receive a royalty of $5 per day for each boat, while the boats are in service, the royalty to run not over 16 years.

THE NATIONAL LEAGUE FOR GOOD ROADS is sending out circulars urging the formation of local Good Roads Leagues in all parts of the country. Full information respecting the organization of such local leagues may be obtained by addressing the secretary of the national organization, 219 Bush St., San Francisco, Cal.

THE MONTREAL BRIDGE SCHEME says the Montreal "Gazette," has received considerable impetus as the result of a conference between Premier Flynn, of the Province of Quebec, and a deputation of interested citizens from the south shore of the St. Lawrence. Resolutions were adopted and presented by the deputation advocating the speedy erection of a bridge across the St. Lawrence River at Montreal. In answer to questions from Mr. Flynn, Mr. C. N. Armstrong, managing director of the Montreal Bridge Company, stated that the estimated cost of the bridge proposed by his company was $6,000,000, and the company asked 15% from the Dominion government, 15% from the city of Montreal and a like amount from the Quebec government. He added, however, that the compapny would be disposed to go on with the work even with a grant from the province slightly reduced from this figure. The capital of the company was said to be $3,000,000, with $700,000 subscribed, and 10% of the latter sum paid up. He said a New York syndicate was ready to build the bridge on the terms named and spend an additional $2,000,000 on terminal facilities. It was understood that the grants asked from the Dominion and the city governments were to extend over 20 years, with the first payment due only upon the completion of the bridge. Premier Flynn said that without giving a definite promise, he was disposed to aid the enterprise as far as the resources of the Province of Quebec would justify. He approved of a railway along the south shore of the St. Lawrence and a bridge at Montreal; but the province had paid out $24,000,000 for railway construction since confederation, and while it was rich in resources the province must realize on these resources and act in a prudent and economical manner.

NASHUA AQUEDUCT; BOSTON WATER SUPPLY.

(With two-page engraving.)

Work is now in progress on the new aqueduct which is to convey a supply of water from the Nashua River to the present reservoir and aqueduct system of the water supply of Boston, Mass. This is one of the most important features of the new Metropolitan Water Supply system, which was described in our issue of March 7, 1895, when we also gave a map of the system. The work is under the direction of Mr. F. P. Stearns, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Water Board. The work is divided into eleven contract sections, as follows:

Section	1.	Closed aqueduct connecting with river	100 ft.
"	2.	Tunnel	4,306 "
"	3.	Tunnel, 6,002 ft.; closed aqueduct, 1,011 ft.	7,013 "
"	4.	Closed aqueduct	5,700 "
"	5.	" "	5,300 "
"	6.	" "	6,400 "
"	7.	" "	5,543 "
"	8.	Assabet River bridge, 350 ft.; closed aqueduct, 30 ft.	380 "
"	9.	Closed aqueduct	6,268 "
"	10.	" "	6,290 "
"	11.	Open channel	15,800 "
Total			63,109 ft.

Beyond the dam the work will therefore comprise the following:

Closed aqueduct	36,642 ft.
Tunnel	10,308 "
Bridge	359 "
Channel	15,800 "
Total	63,109 ft.

Section No. 1 is a very short section leading to Shaft No. 1 of the tunnel; the contract for this has not been let, and the work may be done in connection with the building of the dam. E. D. Smith & Co., of Philadelphia, Pa., have the contract for the tunnel (Sections Nos. 2 and 3). S. Casparis, of Columbus, O., has the contract for the closed aqueduct (Sections Nos. 4, 5, 6, 7, 9 and 10). Jones, Pollard & Co., of Baltimore, Md., have the contract for the Assabet River bridge (Section No. 8), the prices for which were given in our issue of July 2, 1896. Moulton & O'Mahoney, of Boston, Mass., have the contract for the open channel (Section No. 11).

The work was recently visited by a member of the staff of this journal, and we present herewith a comprehensive description of the various parts of the scheme.

The Dam and Reservoir.

The big dam will be on the Nashua River near Clinton, Mass., 33 miles from Boston. As shown by the preliminary plans in our issue of March 7, 1895, it will be a masonry dam, with a height of 145 ft. and a base of 120 ft. The length will be about 1,000 ft., in addition to an overflow weir 450 ft. long, this overflow being almost at right angles to the upstream face of the dam. This will raise the water to 107 ft. above the present level in the river, and form a reservoir of 63,000,000,000 gallons storage capacity, flooding an area of 6½ square miles to an average depth of 46 ft. Land is now being acquired on the site of this reservoir, and numerous buildings and some small towns will be absolutely wiped out. The whole area of the surface will be stripped and cleared in the same way as Reservoir No. 5, which we shall describe in detail in a later article. The borings at the dam site have been completed, and the designs of the dam are now being made. It is hoped to let contracts for the dam next summer or autumn. Besides the dam there will be two large earthwork dikes, shutting off the water from lateral valleys. The borings at one of these dikes have been completed, and they are now being made at the other. The material is for the most part fine sand, and continuous samples are taken from the bore holes, instead of samples at certain intervals, as is the more general practice.

The Tunnel.

The aqueduct commences by a tunnel 10,308 ft. long, having a grade of 1 in 2,500. This is being driven by E. D. Smith & Co., of Philadelphia, and about 80% is now excavated, the work being prosecuted from four shafts and the lower portal. There are eight headings, which are worked by day and night shifts, except that no day or night work is done on Sunday. The material is granite, slate, and schist. The explosive used mainly is 40% and 60% dynamite. All the machinery is worked by compressed air from a plant located at Shaft 4. This plant was furnished by the Rand Drill Co., of New York city. It consists of two 20 × 36-in. duplex Corliss Rand compressors, supplied with steam by a 500-HP. battery of four boilers, and furnishes air at 85 to 90 lbs. pressure for the following purposes:

24	Rand drills		3¼ ins.
2	Double Otis hoists	cylinders,	9 × 12 "
1	" " "	"	7 × 10 "
1	" Lidgerwood hoist	"	8 × 10 "
2	" Worthington pumps	"	7½ × 10 "
1	Single Cameron pump	"	9 × 10 "
1	" Snow pump	"	8 × 10 "
1	" Cameron pump	"	12 × 12 "
Fires in blacksmiths' shop			3

There are two Rand No. 13 sluggers (3¼ ins.) used at each heading and one at each bench. The rate of progress is about 335 ft. of completed tunnel section per week (6 days and nights). The contract time for the completion of the tunnel is December, 1897, but as the contractors are far ahead of the contract requirements for excavation, they hope to finish the work about August, 1897. Mr. T. F. Richardson, M. Am. Soc. C. E. is the engineer of the Dam and Aqueduct Department (Metropolitan Water Board); Mr. Horace Ropes is Resident Engineer, and Mr. J. M. Jackson, M. Am. Soc. C. E., of the contracting firm, is in charge of the work for that company. The drawings and specifications for the tunnel were given in our issue of Jan. 23, 1896.

Closed Aqueduct.

Beyond the tunnel the aqueduct is continued by an arched channel, 10 ft. 6 ins. high and 11 ft. 6 ins. wide, built partly in open trench and partly upon embankment, as required by the nature of the ground. The typical sections are shown in Fig. 1. This part of the work is built upon a strip of land acquired by the Water Board, the normal width being 100 ft. There is a uniform grade of 1 in 2,500, and the curves vary from 320 to 1,910 ft. radius. Some short sections of this work are completed, and one of them is shown in Fig. 2. All masonry, and much of the incidental work, has been stopped for the winter.

Trench.—Where the trench is wholly or partly in rock, it is to be excavated with the bottom and sides (up to the skewback) parallel with the inside of the aqueduct. If there is any water, the trench must be deepened in the center to admit of building a brick drain. The skewback is to be cut into the rock. Below the skewback a limiting line is determined by the engineer and the contractor must not permit any portion of the rock to project within this line. Above the skewback, the contractor may adopt such slopes for the sides of the rock trench as he chooses, but will be paid for slopes of 1 horizontal to 6 vertical. Where the trench is in earth, the excavation is measured as if taken out to slopes of 1 to 1. Two prices only are paid for materials excavated from the aqueduct trench, and other excavations (except borrow pits) namely, one for "rock excavation," which covers all solid rock removed by blasting, and all boulders of 1 cu. yd. or more; and one for "earth excavation" which covers all other materials. The price for "borrowed earth" covers all materials taken from borrow pits.

Embankment.—The banks are mainly of a dry, clean gravel, and have in general a top width of 14 ft., with side slopes of 1¾ horizontal to 1 vertical, but may be made narrower where it is necessary to borrow earth to complete them. The ground at the base is cleared of soil and other perishable matter, and if on a slope transverse to the line of the embankment, the surface is stepped to prevent slipping. The construction of the bank and the position of the aqueduct are shown in Fig. 3, and the following is an extract from the specifications as to the construction of the banks:

The central portion of the bank, beneath the level of the highest part of the base of the aqueduct, to a width 8 ft. greater than that of the base at such level, and to an added width of 1 ft. for each foot below such level, is to be built with extreme care and with carefully selected earth; all stones larger than 2 ins. diameter are to be thrown out. The material is to be deposited and spread in horizontal layers not exceeding 3 ins. in thickness, each layer to be sufficiently watered and very thoroughly rolled with a heavy grooved roller. From time to time during the construction of this portion of the embankments, and, if so required, three times after its completion, this portion shall be so thoroughly saturated with water that it will stand upon the surface. The

FIG. 2.—VIEW OF COMPLETED SECTION OF AQUEDUCT.

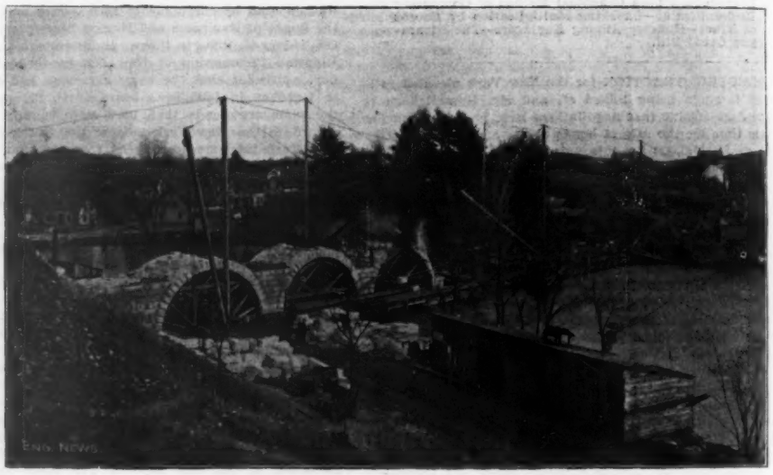


FIG. 9.—VIEW OF ASSABET RIVER BRIDGE.

building of the aqueduct upon such embankments shall not be begun until they have stood six weeks after completion, unless otherwise directed. The other portions of the embankments are to be made of suitable earth (except where the use of rock is directed) free from perishable material, from which all stones that will interfere with the proper rolling of the earth shall be thrown out. The earth for these portions of the embankments is to be deposited in horizontal layers not exceeding 8 ins. in thickness below the level of the highest part of the base of the aqueduct and not exceeding 6 ins. in thickness above this level; and each layer is to be sufficiently watered and thoroughly rolled with a heavy grooved roller. The earth is to be well and solidly rammed with heavy rammers at such places as cannot be reached by the roller. Above the top of the arch, if the earth is well consolidated by teaming over it, the rolling may be omitted. If the engineer shall so direct portions of the embankments may be made with rock taken from the excavations and deposited to such lines

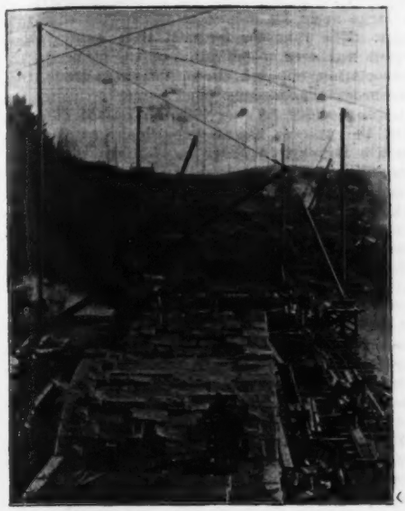


Fig. 8.—End View of Assabet River Bridge.

and slopes as he may direct. To complete the embankments, they are to be carefully dressed to the proper lines and slopes, and a layer of soil applied to them, the black soil being used at the surface. The soil is to be compacted by ramming or rolling and the finished surface shall be brought smooth and true to the required lines and slopes.

Aqueduct Construction.—The bricks used are specified to be the best quality of hard-burnt bricks, burnt hard entirely through, and regular and uniform in shape and size. They shall be of compact texture, and bricks which, after being thoroughly dried and immersed in water for 24 hours, absorb more than 16% in volume of water may be rejected. The mortar for brick masonry is to be composed of 1 part sand to 1 part cement (either American or Portland, according to the character of the work). American cement concrete masonry will be used chiefly for the foundation and side walls of the aqueduct and the foundation of the culverts. Portland cement concrete will be used chiefly in the arch of the aqueduct. The principal clauses of the specifications referring to the concrete work are as follows:

Concrete masonry shall be made of sound broken stones or clean gravel stones and sand and cement of the qualities before specified. The stones shall be of varying sizes; none used in the American cement concrete to be more than 2½ ins., and none in the Portland cement concrete more than 2 ins., and but very few in either to be less than ¼-in. in their greatest dimensions. They shall be free from clay and other objectionable materials. The American cement concrete shall be mixed in the proportions, by measure, of 5 parts of broken stone or gravel to 2 parts of sand and 1 part of American cement. The Portland cement concrete shall be mixed in the proportions, by measure, of 4½ parts of broken stone or gravel to 2½ parts of sand and 1 part of Portland cement.

Special care is to be taken to make the interior of the concrete arch smooth, and to insure the complete filling of the interstices between the stones. The centers shall be smooth, true, strong enough to withstand the strain of ramming the concrete against them, and so built or protected as to withstand the action of the water in the concrete without warping. If the contractor cannot prevent voids beatween the stones on the interior of the arch by suitable ramming, he shall, if necessary, select the finer portions of the concrete to be placed next to the centers, and if this does not accomplish the desired result shall, if required, take a portion of the sand and cement of the concrete, in the proportions specified, and mix them apart from the concrete and apply the mortar thus made in a layer, next to the centers, immediately before placing the concrete formed of the remaining stone, sand and cement. Should any voids be found on the interior of the arch they shall be pointed with neat cement or with cement and sand as directed by the engineer, or the defective work shall be removed and replaced with satisfactory work if so required by him.

Culverts.

The drainage across the line of the aqueduct is provided for by brick culverts, with head and wing walls of dimension stone masonry, and end paving of split stone. One of the 7-ft. culverts is shown in Fig. 3, which also shows a section of the aqueduct in embankment, and one of the smaller barrel culverts is shown in Fig. 4.

Terminal Chamber.

At the end of the closed masonry aqueduct above described is a masonry chamber, Fig. 5, fitted with grooves in which a weir 18 ft. long can be placed, and having three archways in the end wall which discharge into the open channel below the chamber. The normal aqueduct section flares out at the chamber by a bell-mouth opening, as shown by the plan and sections.

Open Channel.

Section No. 11 of the aqueduct is an open channel extending from the terminal chamber, above described, to Reservoir No. 5 of the water supply system, which reservoir we have described in a separate article. This channel is 15,800 ft. long, and follows the line of a brook which now flows into Reservoir No. 5. It is 20 ft. wide on the bottom, with side slopes of 3 horizontal to 1 vertical. In order to prevent a scouring current, and also to prevent trouble from ice in winter, two dams are to be constructed, one at the lower end, and one about half way up the channel. These dams, which are to be of masonry backed with earth, will maintain a minimum depth of about 6 ft. of water. The dams also have very long overflows, so as to cause little fluctuation in the height of the water in the channel, as varying quantities are let down from the river. Six or more stone bridges will be built across the channel. A berm at least 10 ft. wide is to be left on each side of the channel, and the slopes upward from the berm must not be steeper than 2 horizontal to 1 vertical. Where the channel is excavated through muck or through fine sand or other material which will not resist the action of the current, it is to be made so wide and deep that it can be faced with gravel or a riprap of small stones without encroaching upon the regular section.

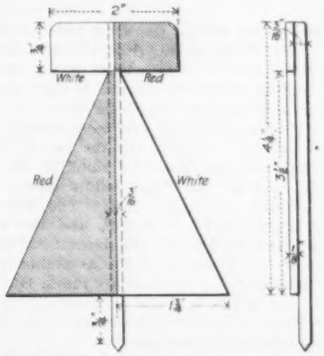
The Assabet River Bridge.

The aqueduct will be carried across Wood's millpond, on the Assabet River, by a masonry bridge 389 ft. long, having seven arches of 29 ft. 6 ins. span. The aqueduct waterway has the normal width and height, but the sides are nearly vertical, inclining slightly to the invert floor. The roof is of brick arches carried by transverse I-beams. Above these roof arches is a concrete filling, covered with cement plastering and asphalt concrete. The 8-in. brick lining has an outer lining of metal to render the aqueduct perfectly watertight. The details of this interesting structure are shown in Figs. 6 and 7, while Figs. 8 and 9 show the progress made up to November, 1896, when work was stopped for the winter.

The concrete masonry will be of three classes: Portland cement concrete, 5 parts broken stone or gravel, 2 parts sand, 1 part cement; American cement concrete (1st class), 5 parts broken stone or gravel, 2 parts sand, 1 part cement; American cement concrete (2d class), 6 parts broken stone, or gravel, 3 parts sand, 1 part cement. The stones are not to be larger than 2½ ins., and only a few smaller than ¼-in. The stone masonry is of gray granite, and is of very handsome appearance. For the pier foundations, a cofferdam was built to exclude the river water. This has 9-in. spruce piles driven to at least 5 ft. below the bottom of the excavation, and connected by waling pieces and cross caps; the sheeting is of 4-in. splined planks.

TRACK FLAG FOR MAINTENANCE-OF-WAY WORK.

The accompanying cut represents a useful device to expedite transit work in lining curves, etc., in maintenance-of-way. It is a small red and white flag or target, used as a backsight flag, being driven into the stake or tie just back of the tack marking a point. Its use saves the time otherwise lost by the whole party when a man is sent back with rod or pencil to give a back sight. With two or three of these flags ("standard section men," as they were locally termed) it is said that three men can make about as much time rerunning curves and tangents, as four men can make without them. They give a well defined



Track Target for Backsight in Maintenance of Way Work.

sight, even at long distances; stand so low that passing trains do not knock them out, and are gathered up at night after the work is done. They are of little use in location or property surveys, but for railway maintenance-of-way field work they are very convenient. The cost will not be more than about 25 cts. each.

For the blueprint and particulars of this device, we are indebted to Mr. G. B. Zahniser, civil and mining engineer, Clendenin Block, New Castle, Pa., who has used it in work on the Pennsylvania Company's lines.

THE ANNUAL MEETING OF THE ASSOCIATION OF GERMAN PORTLAND CEMENT MANUFACTURERS.

By S. B. Newberry.*

The annual meeting of this important association took place in Berlin last February, and the official report of the meeting has lately appeared. The list of members includes representatives of 78 factories, the total product of which amounted in 1895 to 14,450,000 barrels of cement; 12,000,000 barrels of this were made in Germany alone, the balance representing the product of foreign factories belonging to the association.

The President reported a number of complaints in regard to certain brands of cement which are found in the market, and which consist in part of ground blast-furnace slag. He stated that after careful examination by experts, these cements proved to have no claim to the title of Portland cement as defined in the German official standards. Herr Toepffer stated that immense quantities of inferior cement are manufactured in Belgium, and sold abroad as Portland cement, to the great injury of the German manufacturers of high-grade cements. He recommended that efforts should be made to make it generally known in foreign countries what brands are true Portland cements according to the German standards. According to the definition of the German Minister of Public Works, the only products which may legally be sold as Portland cement are those obtained by the calcination of intimate mixtures of lime (or carbonate of lime) and clay.

Report of the Committee on Normal Sand.

At the 1895 meeting a committee was appointed to inspect the deposits of sand at Freienwalde, on the Oder River, from which source the supply of sand for cement testing is obtained, in order to determine whether a constant future supply of sand of uniform quality could be depended upon. The German official requirements recognize no neat tests of cement for tensile or compression

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strength, but specify that cement shall be tested with 3 parts normal sand. This normal sand is the sand from Freienwalde, screened to pass a sieve of 60 meshes to the square centimeter (20 to the lin. in.), and retained on one of 120 meshes per square centimeter (28 to the lin. in.). The report of the committee is an excellent illustration of the thoroughness with which, in Germany, scientific methods are applied to practical work. An abstract of the report may, for this reason, be of interest to American manufacturers and engineers. The selection and adoption of a similar deposit of sand in this country as a standard sand for cement testing, would add greatly to the uniformity and significance of the results obtained.

The committee visited the sand beds at Schiffmuhle, near Freienwalde, from which the Stettin Portland Cement Co. obtain their supply of sand for testing, and from which the normal sand is sifted out at Zullchow. The beds lie on the river near the Freienwalde road, and have already been very extensively worked. On the left are seen brown and dark gray layers of sand, in the middle white, and on the right yellow layers with streaks colored by iron oxide. The workable beds are about 25 ft. in height, and fall away rapidly toward the back of the deposit. A superficial calculation shows that the available material will be exhausted in about six years. It is evident that the bed is a single sand-deposit of the Tertiary lignite formation. Samples of the sand were taken from various points.

The committee then visited another sand deposit at Hammerthal, worked by the Henneberg Fire-brick Co., and situated on the other side of Freienwalde. This deposit is also 25 to 30 ft. thick, and is very extensive, evidently extending through the adjoining mountain. The purest part of the bed shows sand of a uniform grayish-white color. Samples of sand from Schiffmuhle and Hammerthal were tested by the committee, and found to contain only 0.66% of clay. The yield of normal sand (20 to 28 mesh) was found to be, on the average, 34% at both localities.

Tensile strength and compression tests were made with samples of normal sand from Hammerthal and Schiffmuhle, taken in 1890, and also with sand from Schiffmuhle furnished in 1895 by the Chemical Laboratory for Clay Industry in Berlin, in order to determine whether any change in the character of the sand had taken place. These tests were separately made by three members of the committee and by the Royal Experiment Station in Charlottenburg, the same cement being used in all the tests. All results appear in a table given in the original report. The figures obtained by the four experimenters vary considerably. The averages of the four separate tests are given in the following table:

Cement 1, Sand 3. (Lbs. per square inch.)

	10% water. Tension. 7 days.	10% water. Tension. 28 days.	10% water. Compression. 7 days.	10% water. Compression. 28 days.	9½% water. Tension. 7 days.	9½% water. Tension. 28 days.	9½% water. Compression. 7 days.	9½% water. Compression. 28 days.
Sand from Schiffmuhle, 1890	282	352	.....	3,124	299	350	2,304	3,480
Sand from Schiffmuhle, 1895	288	368	2,150	3,131	295	385	2,473	3,537
Sand from Hammerthal, 1890	277	358	2,586	3,651	290	391	2,714	3,693

The above results show the three samples of sand to be practically equal in quality. Slightly higher results are obtained with 9½% water than with 10%, as has been observed by others. At the suggestion of Prof. Martens, enlarged photographs of the three samples of sand were taken, in order that possible differences in the surfaces of the grains might be observed. For this purpose each sample was separated into two grades by a sieve of 81 meshes per sq. centimeter (23 per lin. in.), and the two grades of each were separately photographed with an enlargement of 10 diameters. These photographs will appear in the next number of Contributions from the Royal Testing Stations. No noticeable differences are apparent in the surfaces of the grains in the six photographs taken.

The proportion of coarser and finer particles proved to differ considerably in the three samples of sand. The proportions retained on the 23-mesh sieve were:

Sand from Schiffmuhle, 1890	26%
" " " 1895	18%
" " Hammerthal, 1890	35%

The slight difference in the results of the tension and compression tests indicates that this variation in fineness of the normal sand has little effect on the results. The committee recommended, in conclusion, that the Association take steps to purchase or lease a bed of sand at Freienwalde, of sufficient extent to furnish a supply of normal sand of unvarying quality for testing purposes and sufficient for many years to come. This recommendation was agreed to, and the details left to the officers of the Association.

Report on the International Conference for the Unification of Methods for Testing Materials of Construction.

This particular conference was held in Zurich, Switzerland, in September, 1895. It was attended by over 300 representatives from all countries, including four from the United States. Only two representatives from England were present, and this slight participation on the part of that country was especially remarked. Prof. Von Tetmajer opened the meeting with an address, in which he stated that this conference, like its predecessors, was an entirely free convention, the proceedings of which had no binding character, and were intended only to give opportunity for a mutual exchange of views.

A new international association was organized under the name of "The International Association for the Testing of Technical Materials." It is intended that a journal shall be published by the society. Professor von Tetmajer was chosen President, and it was decided that the next meeting should take place in Stockholm in 1897. At that meeting a day will be set apart for the discussion of questions relating to hydraulic cements. The following meeting will be held in Paris in 1900.

Report of the Committee on Uniform Testing Apparatus.

For the manufacture of briquettes by hand, the committee recommended the use of a planed cast-iron plate, 10 × 12 × 2 ins. in size, in place of the heavy glass plate generally employed. Tests by the committee are in progress, to determine whether cements should be tested with sand in the proportion of 1 to 1, as well as 1 to 3. These experiments will determine whether tests of the mixture 1 to 1 do not give the same errors as those of neat cement, in consequence of which neat tests are wholly rejected in Germany. Tests of neat cement are however largely practiced in other countries, to the great disadvantage of the consumer, since they fail to distinguish between coarse and fine-ground cements.

It is well known that the results of cement tests, especially with sand, depend quite as much on the thoroughness with which the mortar is mixed and worked as on the method of filling the molds. For this reason many attempts have been made to devise a suitable mixing machine which should replace hand-labor and give uniform and reliable results. Such a mixing machine was shown at the meeting by Schmelzer. This machine consists of a pan with rotating spoons, by which the pushing and stroking action of the trowel in hand-mixing is closely imitated. It was decided to send the machine to the Royal Testing Station for thorough trial.

Referring to the varying results obtained by different experiments in the preparation of briquettes and compression cubes by hand-labor, the chairman pointed out that the tests of the same cement with the same normal sand by the different members of the committee on normal sand showed a striking lack of agreement. For example, the tensile strengths obtained by the four experimenters with the three sands tested, at 7 and 28 days, using 9½% water, were as follows:

Cement 1, Sand 3. Tensile Strength in lbs. per sq. in.

Sand from:	Experimenter. Dr. Goslich.	Dr. Tomei.	Dr. Schumann.
Schiffmuhle, 1890, 7 days	243	339	295
" " 28 days	314	386	373
" 1895, 7 days	290	390	306
" " 28 days	385	406	385
Hammerthal, 1890, 7 days	244	355	304
" " 28 days	361	470	389

As these tests were all made according to the German official requirements, and by experts in the testing of cements, the lack of agreement shown points to the necessity of some method of mechanical mixing of the cement, sand and water.*

The chairman referred to the application by Bocklen for a patent on the mixing of mortar on a large scale by means of pans with edge-runners. The inventor claimed that this process yields mixtures of enormous tensile strength. The Association opposed the patent, on the ground that this process had already been carried on in practice. It was decided by the German Patent Office to test the process by an experiment at the Star Stettin factory, in order to determine whether the alleged improvement in the quality of the mortar is due to a change in its character, or whether this result is to be attributed to a partial pulverizing of the sand, producing fine, sharp-edged grains. Comparative tests of mortar prepared by hand and by the pan showed the latter to give decidedly higher results. Microscopical examination proved that no pulverization of the sand had taken place in the pan, and that the immense increase in the strength of the mortar is due to the energetic and long-continued mixing-action of the apparatus. This experiment shows clearly the need of some form of mechanical mixing machine for cement testing.

Herr Hofmann recommended the use of a trough containing two spiral conveyors revolving in opposite directions, a machine similar to that largely used in biscuit manufacture. Herr Hoch stated that he has for the past two years employed a small mixing-drum, with steel balls, for the preparation of cement mortar for testing. This mixing-drum is 16 ins. in diameter and 8 ins. long, and contains 6 steel balls. The cement, sand and water are introduced, and the apparatus revolved 150 times. The resulting tests are very uniform and always higher than those obtained by hand mixing. In the preparation of concrete on a large scale similar mixing drums have given excellent results, the concrete showing about 30% higher strength on compression than that mixed by hand. In building the Munderkingen Bridge, a concrete consisting of cement 1, sand 2½, and gravel 5 was made in a mixing drum. This concrete showed a compression strength of 4,725 lbs. per sq. in., while the same mixture made by hand showed only 2,416 to 2,558 lbs.

Herr Gary stated that experiments had already been made at the Royal Testing Station with the mixing trough recommended by Herr Hofmann, but that the use of the apparatus was abandoned, owing to the difficulty of producing a good mixture and the great trouble of cleaning out the machine. He stated also that in his opinion the mixing drum proposed by Herr Hoch would also be tedious to clean, while the small mixing pan presents no difficulty in this respect. Herr Toepffer stated that mortar mixed in a pan is always whiter, and is also much less liable to show shrinkage cracks on hardening, than that mixed by hand. Herr Schott and Herr Meyer reported unfavorably in regard to the results obtained with the mixing drum. Professor Martens of the Royal Testing Station stated that the whole question requires careful study and experiment, especially with reference to possible changes in the character of the materials by the grinding action of the machine employed. He promised that the Royal Testing Station will take up the question with the greatest interest and will make careful tests with all forms of apparatus supplied for the purpose.

*In this connection, see paper, by Prof. Porter, Eng. News, Mar. 5, 1896, stating results obtained at different well-known cement-testing laboratories in this country, with same sample of cement, at 7 days. Results with 3 parts sand vary from 75 lbs. to 247 lbs.

Dr. Gary reported that experiments are in progress with a view to secure greater uniformity in the sieves used for testing cement for fineness and for screening normal sand. For this purpose samples of wire screen were collected from various manufacturers, and photographed with an enlargement of 10 diameters. By this means the width of the mesh and thickness of wire can be accurately measured. A number of photographs were shown at the meeting, in which the imperfections of commercial wire netting were clearly brought out. Much careful study will be required to solve the problem of uniformity in sieves.

Report of the Committee on Tests for Constancy of Volume and Time of Setting.

The committee reported progress, stating that experiments are under way to determine the relation between hot tests for constant volume and the behavior of cements in practice. A great number of samples of cements which do not satisfactorily pass the hot test were furnished by members of the association. These are being carefully tested by the various methods proposed by Michaelis, Tetmajer, Maclay and others. Small objects have also been prepared from these cements by the firm of Dyckerhoff & Widmann in Biebrich, and will be closely observed during a period of several years. Some results of these experiments will probably be presented at the 1897 meeting; but definite conclusions can hardly be reached before 1898.

Report of the Committee on the Influence of Magnesia in Portland Cement.

At the convention of 1895 the committee reported that no harmful effect of magnesia up to 8%, had been detected. Dyckerhoff, however, in a minority report, presented the results of most careful experiments extending over five years, which showed that more than 4% magnesia in well-sintered cement caused a gradual falling off in strength at long periods, while actual cracking was observed with 8% magnesia. In case of light-burned cements, however, which were not sintered, 15% magnesia caused no bad results. In consequence of the conflicting views, a new committee was appointed with Dyckerhoff as chairman, with instructions to take the whole subject up anew. At the 1896 meeting Dyckerhoff presented a report of progress, explaining the program of work which the committee has adopted and is at present engaged upon. At a meeting of the committee held in November, 1895, it was decided that samples of cement clinker should be prepared by each member, under the following conditions: Natural cement material, containing about 2% magnesia is to be used as a basis, and dolomite added as required to bring the percentages of magnesia to those agreed upon.

Mixtures are to be prepared with 5% and 10% magnesia. In the first series the proportion of lime to silica + alumina + iron oxide is to be as 1.9 to 1, and magnesia added to the required percentage. In the second series the proportion of lime + magnesia to silica + alumina + iron oxide is to be as 1.9 to 1. There will thus be four mixtures prepared, two with added and two with substituted magnesia. The raw material is to be ground to such fineness that not over 10% remains on a sieve of 180 meshes to the linear inch.

The burning is to take place in vertical or ring-kilns, not in test-kilns. Two samples of each mixture are to be prepared, one sintered to the normal degree, and one harder burned. The resulting samples of clinker, eight in number from each member, are to be forwarded to the Royal Testing Station to be ground and tested. The grinding shall be such that the cement shall leave not over 22% residue on a sieve of 180 meshes to the linear inch, and not over 3% on a sieve of 76 meshes.

Tests will be made of specific gravity, expansion as measured by the Bauschinger apparatus, constancy of volume, time of setting, and tensile strength with one and three parts sand up to five years. The mixing and burning of the material on a manufacturing scale requires some time, but was reported to be actively under way. Samples had been received from one member at the time of the general meeting.

Report of the Committee on the Action of Sea Water on Cement.

The results of experiments made in 1894 and 1895 at the Island of Sylt were unsatisfactory, owing to lack of skill on the part of the operator intrusted with the tests. It was therefore decided that a special expert should be trained for this work at the Royal Testing Station at Charlottenburg, and that the experiments should be begun anew according to an improved program. The preliminary work is now completed, and the experiments are in regular progress. The expense of the investigation is paid from a joint appropriation by the German government and the Society of German Cement Manufacturers. The work is not yet far enough advanced to allow definite results to be published. The committee reported, however, that all briquettes allowed to harden in sea water gave lower results than those kept in fresh water, also that all samples of mortar to which slaked lime had been added were more or less strongly attacked by the sea water.

Dyckerhoff presented the results of his own tests of the effect of the water of the North Sea. Owing to the fact that the addition of slaked lime to mortars poor in cement produces a greater density, it was his expectation that cement-lime mortar would resist the action of sea water better than that without lime. This expectation was not realized, the sea water acting to a marked degree upon the lime contained in the mortar.

In this connection, the results of investigations by Herr Sympher, inspector of the Baltic Ship Canal, were also presented in full. These include comparative tests, in fresh and salt water, of Portland cement, Roman (natural rock) cement, trass and pozzuolana cements, and hydraulic lime, extending over two years. Full tables, showing tensile and compression strengths, appear in the report. The results show that the water of the Baltic has less injurious action on mortars than that of the North Sea. All samples containing slaked lime stood well in the Baltic water up to two years, except that composed of Portland cement 1, lime ½, sand 4, which showed injury.

Mixtures of Portland cement and sand showed decidedly lower results in salt water than in fresh, at all periods from 1 week to 2 years. Portland cement and sand with addition of slaked lime stood well in fresh water, but showed greatly inferior strength in salt water. Roman cement, trass and pazzuolana cements, all showed decidedly lower tests in salt water than in fresh, but were not noticeably attacked. Hydraulic lime showed especially bad results in sea water, the test-pieces being much attacked and in part destroyed at one year and two years. Hydraulic lime with 1 part sand showed at two years, in fresh water 298 lbs.; in salt water 64 lbs.

A report was published in 1889 by the French Minister of Public Works, giving the results of observations on the effect of sea water, extending over ten years. Portland cement concrete blocks showed better resistance than masonry blocks. None of the hydraulic limes tested, not even the famous lime of Teil, resisted the action of moving sea water longer than four or five years. Quick-setting cements were strongly attacked after eight to ten years. On the other hand, blocks made from Portland cement were still in excellent condition after ten years in sea water. As the injurious effects of sea water on certain kinds of mortar are not evident until after five or even eight years, it appears very necessary that the experiments at Sylt should extend over a period of ten years or longer.

Report on the Concrete Bridge at Inzigkofen.

Dr. Leube presented a full description of the concrete-arch bridge erected in 1895 over the Danube River at Inzigkofen. The total span of the bridge is 144 ft. The materials were used in the following proportions:

Foundations	cement 1, sand 3, gravel 6
Piers	cement 1, sand 4, gravel 8
Arch	cement 1, sand 3, broken stone 4
Surface	cement 1, sand 2

All mixtures were made by hand labor. The total cost of the bridge was $6,650. The two halves of the arch meet in the center in a massive cast-iron swivel-joint. Full details of the construction, with a photograph of the bridge, appear in the report.

Herr Hoch described a number of other bridges of similar construction, among them the Munderkingen bridge over the Danube, built in 1893. The designer of this bridge was awarded the Telford medal by the British Society of Engineers. The first bridge built in the United States after this design was that erected in 1895 at Belleville, near St. Louis. Herr Hoch stated that in the construction of bridges of 50 meters (164 ft.) span and over, concretes 1 to 12 or 1 to 14 are too poor to give the required strength.

Herr Eugene Dyckerhoff referred to the great railway bridge at Dresden, in which the central swivel is of stone instead of iron. He agreed with Herr Hoch that rich concretes should be used, provided these prove not to be in themselves an element of danger. Experiments are now in progress at Charlottenburg to determine the expansion and contraction of various concretes under the influence of heat and cold, dryness and dampness. A report of these experiments will be presented at the next annual meeting. Certain results have, however, already been reached, which are contrary to generally prevailing convictions. For example, it is usually believed that the tensile and compression strengths of cement-concrete stand in the relation of 1 to 10. Tests at Charlottenburg of 8-in. cubes of concrete containing broken stone up to 1 inch diameter, show this relation to be about 1 to 20. It was also shown that in compression tests cracks form long before actual crushing takes place. For building purposes the test of the load required to produce cracking is the only significant one.

As to the proportions advisable in concrete, Dyckerhoff pointed out that the addition of broken stone to mixtures of cement, sand and gravel increases rather than reduces the strength. A mixture of 1 cement, 6 sand and gravel, and 8 broken stone is at least as strong as the same mixture without the stone. All reports on the composition of concrete should state the amounts of sand of the fineness of ordinary building sand, also the amount of gravel. There is an immense difference between a sand containing no gravel and one which contains perhaps 60% true sand and 40% gravel. A mixture of 1 cement and 10 of true sand would be so poor that its use would be almost incredible. In Dyckerhoff's constructions, gravel sand (kiessand) is always used. This consists of nearly equal parts of sand and gravel.

Herr Hoch stated that compression tests of concrete in the form of cubes and also in cylinders 10 ins. in diameter and 39 ins. high were made at Stuttgart during the past year. The results, in lbs. per square inch, were as follows:

	Cubes.	Cylinders.
Cement 1, sand 4½, gravel 9	1,604	1,163
" 1, " 4½, broken stone 9	2,556	1,405

In the Munderkingen bridge, the concrete was composed of cement 1, sand 2½, gravel 2½, and broken stone 2½; or 1 to 7½. The compression strength of this mixture at 28 days was 3,607 lbs. per sq. inch. This high result is not due to the addition of broken stone, but to the thoroughness of the mixing done in the mixing drum.

Herr R. Dyckerhoff stated that concrete cubes for the Dresden bridge were made last year by Dyckerhoff and Widmann in Biebrich. These cubes were about 1 meter square, and the center of each was made of a rich concrete, cement 1, sand 1, broken stone 1. A decided rise in temperature was noted during the manufacture of these cubes, and a thermometer inserted in a boring showed a rise of 17° C. To test this question further, 10 in. cubes of rich cement-motar and rich and poor concrete were prepared, and in the centre of each a thermometer was inserted. The cubes were embedded in sawdust and the rise of temperature noted. The maximum temperature was reached in 16 to 18 hours.

	Rise in Temperature (in degrees centigrade.)
Cement 1, sand 1, 11% water	21.
" 1, " 1, broken stone 1, 11% water	17.5
" 1, " 3, gravel 6, 9.5% water	3.

The same cement with 28% water, without sand, tested in the usual manner in a quantity of only

400 grams showed a rise of temperature of only 1½°.

Report on the Double Pendulum Mill.

Herr Mecke gave an account of the performance of this mill, which from the description appears to resemble the Huntington mill. The latter is used to some extent in the United States for grinding cement clinker. In the course of the discussion which followed, reports were given on the performance of the Griffin mill and the Tube mill. As these are rapidly coming into use in this country, the figures reported will probably be of general interest.

Herr Mecke stated that the centrifugal force of a rotating body increases, as is well known, with the square of its velocity. This principle allows the development of great power in grinding by the application of high velocities, and is practically applied in the Morel ball-mill, the horizontal ball-mill, the Frisbee-Lucop mill, the Griffin mill, and the double-pendulum mill. In the last three, cylindrical or conical rollers revolve against the inner surface of a ring.

According to Herr Mecke, the Frisbee-Lucop mill has the disadvantage that the rotating parts

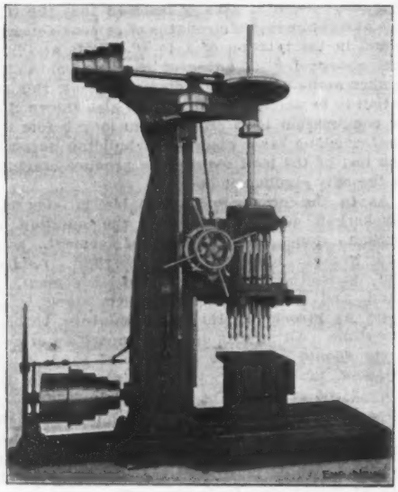


Fig. 1.—Eight Spindle Multiple Drill, built by Baush & Harris Machine Tool Co., Springfield, Mass.

which drive the rollers work in the material and are thus rapidly worn. The Griffin mill is free from this objection, but has the drawback that the roll describes an irregular polygon within the ring, acting by a series of blows which are very trying to the machine and foundation. The double-pendulum mill has two rolls hanging on vertical shafts, which swing out against the ring by centrifugal force, like the balls of an engine-governor. The rolls revolve uniformly against the ring, balancing each other so that the mill runs smoothly and requires no massive foundation. One of these mills has been in operation at the Hemmoor Portland Cement Works since December, 1895, and showed a production of about 14 barrels of cement per hour, ground to such a fineness that 3.3% remained on a 75 mesh sieve and 14% on a 180 mesh sieve. The power required is 35 to 40 HP.

A comparison was made of the output of various types of mill operating in the same factory. One horse power hour gave the following quantity and fineness in each mill, respectively:

Buhr-stones, 59 lbs. per hour, residue on 180 sieve.... 20%
Griffin and double-pendulum mill, 147 lbs. per hour, residue on 180 sieve..... 15%

It thus appears that buhr-stones require more than twice as much power as mills acting by centrifugal force.

Dr. Prussing, director of the Hemmoor factory, stated that his experience justified him in giving the preference to the double-pendulum mill over all other forms of grinding apparatus. It was found possible at Hemmoor to grind with this mill 12.8 bls. per hour to such a fineness that only 1 to 2% remained on a 75-mesh sieve and 5 to 8% on a No. 180 sieve. Such fine grinding is undesirable, since few masons understand how to use such fine-ground cement to advantage, and the manufacturer who furnishes cement of this fineness is met with complaints rather than gratitude. Coarser screens were therefore used on the mill, which gave a production of 14.6 barrels per hour, with a residue of 3.9% on No. 75 and 16.7% on No. 180. The power required per barrel of cement was about the same as with the Griffin mill. The Griffin mill gave 8½ bls. per hour, of the above fineness, with 22 HP. Dr. Prussing gave the preference to the double-pendulum mill over the Griffin mill in consequence of its more quiet running and the much more uniform wearing of the rolls and outer ring.

Herr Foss, of Copenhagen, and Herr Meyer, of the Malstatt Portland Cement Works, reported results obtained with the tube mill. This consists of a horizontal cylinder about 16 ft. long and 4 ft. in diameter, lined with porcelain tiles and partly filled with natural flint balls. The mill revolves 26 times per minute. The clinkers are crushed to the fineness of coarse sand before feeding into the tube mill. According to Herr Foss, the first tube mill made is still in operation at Aalborg, having run 9,000 hours and produced 112,000 barrels of cement without repairs or stoppages. The production is about 13 bls. per hour, to a fineness of 13% on No. 180. It is found that about 2 lbs. of flint balls must be introduced for 80 lbs. of cement ground. Herr Meyer stated that the replacement of buhr-stones by the tube mill in the Malstatt factory increased the output 50%, with a saving of 12% in power. Other speakers reported favorably on the Griffin mill, stating that in their experience the wear of the rings and rolls was reasonably uniform.

A number of other interesting papers were presented, among which may be mentioned that by Dr. Passow on the action of carbon dioxide on cement motar, and that by Dr. Moeller on the new Moeller-Pfeiffer drying system for cement material. An abstract of these reports would, however, unduly extend the limits of this paper.

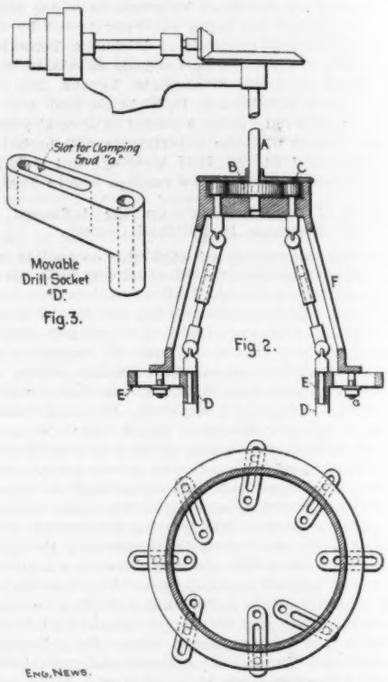
AN EIGHT-SPINDLE MULTIPLE DRILLING MACHINE WITH ADJUSTABLE SPINDLES.

We illustrate herewith an eight-spindle vertical multiple drill, built by the Baush & Harris Machine Tool Co., of Springfield, Mass, which has some novel and interesting features. Any number of drills up to eight, and any size of drills up to 1 in. may be used. The drills may be arranged in a straight line, or so as to take any position or "layout" that may be desired within an 18-in. circle. The machine has a large vertical range, as is seen from the photograph. The head is counterbalanced and is moved vertically on the post by a rack and pinion operated through a worm gear by a vertical feed shaft on the side of the post. This feed is made either automatic or hand fed by use of a disengaging feed clutch at the side of the head.

The mechanism by which the position of the drills is adjusted is shown in the sketches Figs. 2, 3 and 4. The shaft A drives through the gear B and pinion C, which in turn drive through the telescoping universal joints to the drill sockets D.

These drill sockets do not move up and down independently of the head, but are firmly held in place by the arms E, which are adjustable to any point within their radius on a horizontal plane. They are secured to the head F by fixed studs A, which allow of their being moved and clamped where desired. Fig. 3 shows one of the drill sockets, and Fig. 4 shows roughly how the drills may be located at will to make any desired layout. When drilling, the entire head feeds downward, insuring the same depth of hole for each drill, provided the drills are of equal length.

Besides the vertical machines like the one here shown with from 8 to 16 spindles, the company builds horizontal machines of the same capacity, with either double or single heads. With a double head drill all the holes in both ends of a cylinder may be drilled at the same time. The following are a few of the dimensions of the 8-spindle vertical machine: Total height when carriage is at its extreme height, 139 ins.; size of bed, 116½ ins. long, 36 ins. wide, 7 ins. thick; greatest distance from end of spindles to bed, 50 ins.; greatest distance from face of upright post to center of circular carriage, 20 ins.; width of face on post, 14½ ins.; length of carriage on post, 50 ins. Spindles fitted for Morse taper No. 3; traverse of head, 37 ins.; weight, about 8,400 lbs.



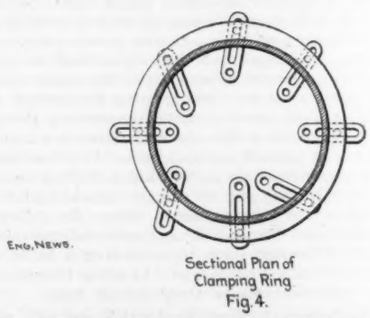


Fig. 2.—Sectional View of Head. Fig. 3.—Drill Socket.
Fig. 4.—Clamping Ring of Drill Head, with Drill Sockets in Various Positions.

DETAILS OF EIGHT-SPINDLE MULTIPLE DRILL.

ENGINEERING WORKS IN JAPAN DURING 1896.

By C. Kadono, C. E.*

Japan has grown in every respect at a wonderful rate in the last few years. The government budget for the coming fiscal year, if it passes the Diet as it stands, would be about 240,000,000 yen (yen = 52 cents U. S. currency)—a sum nearly three times the government expenditure of five years ago. Industrial activity has by no means been behind the governmental expansion. Enterprises of all descriptions have been planned, and many of them will, no doubt, materialize during the coming year.

The total railway mileage in operation at the end of 1896, was 2,409 miles, showing an increase of 170 miles during the year. This increase is entirely in the lines owned by private companies; the government railways have not been extended, but heavy works of improvement have been carried on in the northwest, and double-track grading has been done. The year has been a very active one with respect to railway projects, and the capital stocks, although not entirely paid up, of all chartered railways aggregate over 125,000,000 yen, excluding the government railways. The increase in the operating mileage seems rather small; but it is due to the fact that most of these new roads are yet still in the stage of construction or of preparation for it. The lines under construction amount to 500 miles in round number, and by the end of 1897 we shall see the greater part of those open for traffic.

I would not encourage American contractors to come to Japan to engage in railway works, as they are sure to fail owing to their ignorance of our customs and usages in contract works, and also to some other complications defying solution by any other than native contractors. But there

*Chief Assistant Engineer, Sanyo Railway Company, Hiroshima, Japan.

is a scarcity of good and reliable contractors sufficient to cause retardation of the works on hand, to some extent. We do need solid, substantial contractors, either individuals or corporations. Labor has advanced in its price fully 30% in the last five years, and the time may not be far distant when machinery may be advantageously substituted for the manual labor now employed. The Sanyo Railway has purchased 10,000 tons of 60-lb. Carnegie rails; but as their trackmen are not accustomed to the American permanent way material, having been brought up on English tracks, they complain of their inconvenience. But only a short time would be needed to train them to the new order of things. The Nankai and Koya Railways have also bought American rails.

The Tokyo Water Works enterprise has made its scheduled rate of progress notwithstanding some drawbacks caused by the pipe-scandals. It will be a year and a half before it is completed, and the work will then have extended over six years, and the total cost will be 6,000,000 yen. Kobe and Hiroshima, cities of about 100,000 population each, have done some preliminary work on their water supplies. The Osaka Water Works are almost completed, and the city has a splendid service now. The cost of the plant was about 4,000,000 yen.

The project for the harbor improvement in Osaka has been approved by the Engineering Council of the government, and the work which will be started this year will occupy seven years, the estimate being 13,000,000 yen. Wharfage for a hundred vessels of 5,000 tons each is to be provided for. Some harbor work has also been done in Yokohama and Nagasaki.

The improvement and flood protection of about a dozen larger rivers and streams in the country are placed under the government engineers in the Department of the Interior. The appropriation for 1896 was 1,430,000 yen. Among these, the plan for the improvement of the River Yodo-gawa, when started, will be of interest, as it is proposed to there build some movable steel weirs, and to boldly rectify the river course. On other rivers the work was mostly in levees and fascine mattresses.

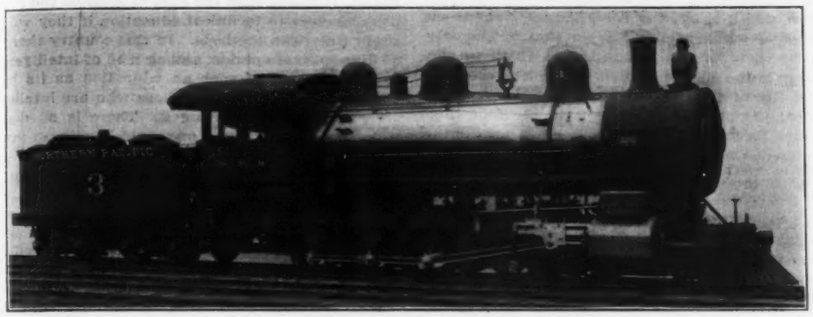
Very soon after the acquisition of the Formosa Islands from the Chinese, a submarine cable telegraph, connecting the islands with Kiushu, the island to the southwest of the main island, was partly laid, from Kagoshima, in Kiushu, to one of the Luchu Islands. As the weather was unfavorable during the winter, the laying of the remaining section was postponed until the spring of this year. The total distance would be about 730 miles. A cable-laying ship was brought from Glasgow for this purpose, and this ship is now busily engaged in laying short cables to detached islands off the main island coast.

The Engineering Department in the Imperial University, Tokyo, is the only institution in the country which educates and sends out qualified engineers. Its curriculum and staff of teachers are superior to the majority of European and American technical institutions. Due to the great demand for engineers in recent years, the Department has grown rapidly. Its students are sent from six preparatory colleges, and the total number of the students recorded for the year in the Department is 345; of these 100 are in the civil engineering department, and 68 in the mechanical engineering sections. In about a year, a similar institution is to be established as a Department in the Kyoto University. There are a few separate schools which are doing successful work in educating transitmen and rodmen.

COMPOUND TWELVE-WHEEL LOCOMOTIVES; NORTHERN PACIFIC R. R.

Among the largest and heaviest locomotives ever built are four engines recently built for the Northern Pacific R. R. by the Schenectady Locomotive Works, of Schenectady, N. Y., and we are indebted to the builders for the photograph from which the accompanying cut has been prepared.

These engines are not regular road engines but are for service as helpers for freight trains on the Rocky Mountains, being coupled on ahead of the trains and not used as pushers. They will be used on a grade of 2.2%, 17 miles long, between Helena and Missoula, Mont. In our issue of Jan. 21 we gave a list of five types of heavy pusher engines, the driving wheel loads of which ranged from 15,300 to 18,500 lbs. per wheel, but these Northern Pacific R. R. engines have a load of 18,750 lbs. per wheel.



TWO-CYLINDER COMPOUND TWELVE-WHEEL LOCOMOTIVE; NORTHERN PACIFIC R. R.
Schenectady Locomotive Works, Builders.

They are two-cylinder compound engines of the twelve-wheel or mastodon type, having eight driving wheels and four truck wheels. The cylinders have the exceptionally great stroke of 30 ins., and the boiler is 6 ft. diameter at its smallest ring. It will be seen that the piston rods are extended through the front cylinder covers and that the valve rods are inclined. Jerome metallic packing is used for the piston rods and valve stems, and the pistons have cast iron packing rings sprung into position. The slide valves are of the Allen-Richardson balanced pattern. The driving wheels have American cast steel centers, with steel tires secured by shrinkage. The main driving boxes are of cast steel, and the others of steeled cast iron. The engine truck wheels have cast iron spoke centers and steel tires. The tender trucks have cast iron plate wheels; they have frames of 10-in. steel channels, with center bearings on both trucks, and additional side bearings on the back truck.

The boiler and firebox are of carbon steel. The circumferential seams are double riveted, and the horizontal seams have butt joints, sextuple riveted, with inside and outside welt strips. Magnesia sectional covering is used on the boiler, dome, and cylinders. The crown sheet is supported by 1⅛-in. radial stays. The staybolts are of Sligo iron, 1 in. diameter, and the tubes are of charcoal iron, No. 12 W. G. in thickness. The firebox has a firebrick arch supported on water tubes, of the railway company's style, and rocking gates also of the railway company's style. A sectional ashpan is used. The exhaust pipe is single and high, with nozzles 5¼, 5½, and 5¾ ins. diameter. Bituminous coal is used for fuel. The feed is supplied by two Seller's injectors, and there are three 3-in. Ashton safety valves fitted on an independent mounting. The whistle is placed on an elbow at the left hand side of the dome. There are two sandboxes, each fitted with a Dean sand-feeding device. Among the other special fittings are the McIntosh blow-off cock and the Kewanee reversible brake beams. The engine is fitted with the American brake on all driving wheels, operated by air; the Lechatelier water brake on the cylinders, the Westinghouse automatic air-brake on tender and for the train (with 9½-in. air pump), and the Westinghouse train signal.

The leading dimensions of these ponderous engines are given in our standard form in the following table:

Twelve-wheel Locomotive; Northern Pacific R. R.	
Running Gear:	
Driving wheels, diameter	4 ft. 7 ins.
Truck wheels, diameter	2 " 4 "
Tender wheels, diameter	2 " 9 "
Engine truck	Swing bolster.
Journals, driving axle	9 × 10 ins.
" coupled axles	8½ × 10 "
" truck axles	6 × 11 "
" tender axles	4½ × 8 "
" main crank pins, main rod	6½ × 6 "
" main crank pins, side rods	7 × 5½ "
" side rod crank pins, front and back	5 × 3¾ "
" side rod crank pins, intermediate	5½ × 5 "
Wheel Base:	
Driving	15 ft. 6 ins.
Total engine	28 " 4 "
" tender	15 " 3 "
" engine and tender	53 " 8 "
" length of engine and tender	62 " 1 "
Weight in Working Order:	
On driving wheels	150,000 lbs.
On truck wheels	36,000 "
Engine, total	186,000 "
Tender, empty	36,300 "
Cylinders:	
High pressure (1)	23 × 30 ins.
Low pressure (1)	34 × 30 "
Piston rod, diameter	3¾ "
Pistons, horizontal thickness	4¾ and 5¾ "
Valve Gear: Type	Link.
Steam ports: h. p., 2⅛ × 20 ins.; l. p., 2⅛ × 23 ins.	
Exhaust ports h. p., 3 × 20 ins.; l. p., 3 × 23 ins.	
Bridges	1⅝ "
Slide valves	Allen-Richardson balanced.
Lap, outside	1⅛ ins.
Clearance, inside	⅛-in.
Maximum travel	6½ ins.
Boiler.—Type	Extended wagon-top.
Diameter of barrel, outside first ring	6 ft.
Thickness of plates in barrel and outside of firebox:	½, 11-16, 13-16, ⅞, ¾, ⅝, 9-16 in.
Working steam pressure	200 lbs.
Firebox:	
Length, inside	10 ft. 3-16-in.
Width, inside	3 ft. 6 ins.
Depth at front	6 " 5 "
Depth at back	6 " 1½ "
Thickness of side plates	5-16-in.
" of back plate	5-16-in.
" of crown sheet	⅜-in.
" of tube sheet	½-in.
Grate area	35 sq. ft.
Radial stays, diameter	1⅛ ins.
Staybolts, diameter	1 in.
Water space, width, front	4½ ins.
" " " sides, above grates	3½ to 4 "
" " " back, at crown	3½ " 4½ "
Tubes:	
Number	332
Diameter, outside	2¼ ins.
Length over tube plates	14 ft.
Heating Surface:	
Tubes	2,721.60 sq. ft.
Water tubes	15.30 " "
Firebox	206.51 " "
Total	2,943.41 " "
Miscellaneous:	
Exhaust nozzle, diameter	5¼, 5½, 5¾ ins.
Smokestack, diameter inside, at top	1 ft. 6 "
" " " near bottom	1 " 4 "
" height from rail to top	14 " 10 "
Capacity of tank	4,000 gallons
Capacity of coal space	15,000 lbs.

THE PARIS EXPOSITION OF 1900 is exhaustively reported upon by Consul General Samuel E. Morss, of Paris. The exposition is to open on April 15, and close on Nov. 5, 1900. The architectural details are not yet completed, but one of the chief buildings to be erected is a magnificent Fine Arts Hall, to permanently replace the old Palais de l'Industrie, of 1855, which is now being demolished. A new bridge, that of Alexander III., is being built across the Seine in front of the Esplanade des Invalides. As a guarantee fund for the Exposition $20,000,000 has been provided; and to this fund the National government subscribes $4,000,000 and the City of Paris a like sum; the remainder, or $12,000,000, is obtained from an emission of bonds of 20 francs, or $4.00, each. These bonds bear no interest and are redeemable in tickets of admission of 1 franc each; in lieu of interest the holder participates in 29 drawings in a lottery, with 4,313 prizes aggregating in value $1,200,000; the prizes ranging in value from $20 to $100,000. The bonds also give the holders the right to considerable reduction in railway and steamboat fares in France, or to 25% reduction in the admission price to special entertainments on the grounds. No charge is to be made to exhibitors for space, water, gas, steam or other motive power; but the exhibitor must pay for connections, shafting, packing and repacking, storage of cases and installation; the latter including all special passageways, ceilings, platforms, railings, etc. The tariff regulations are very liberal as regards foreign exhibitors. They will be exempt from statistical dues and "octroi," unless later entered for consumption in France. Diplomas alone will be awarded to exhibitors; but these will be classified as grand prize, gold, silver, bronze and honorable mention diplomas. All industrial, agricultural and miscellaneous exhibits will be introduced into the exposition between Dec. 1, 1899, and Feb. 28, 1900.

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ADVERTISING RATES: 20 *cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.*

A decision was given not long ago in Buffalo which will interest every engineer who has ever been under cross-examination on the witness stand, and has had a lawyer try to break the force of his testimony as an expert by attempting to show that he was not a "practical" man. The city charter of Buffalo provides that the inspectors of buildings "shall be practical building mechanics of not less than five years' experience in their trade." The Board of Aldermen of the city refused to order a warrant drawn for the payment of a certain inspector on the ground that he was not "a practical building mechanic." The inspector appealed to the courts, setting forth that "for more than five years prior to his appointment as a building inspector, he had been a student of architecture and building construction, theoretical and practical, in the offices of well-known architects, and had worked upon buildings of different kinds, and made plans for and superintended the construction of such buildings and had inspected the work of their construction in all its branches. That he was thoroughly familiar, both theoretically and practically, with all the details of the mechanism and construction of buildings and with building materials."

The judge in his decision fully sustained the position of the inspector, and his opinion is an admirable answer to those who still cling to the opinion that an engineer is necessarily a more "practical" man because he has fired a locomotive, run a lathe, held a drill, or done some of the work of a skilled laborer in connection with engineering. We quote from it as follows:

> The words of the charter prescribing the qualifications of an inspector of buildings should receive such reasonable interpretation as will make them effective for the accomplishment of the ends sought, and that is, among other things, to exclude from the position in question inexperienced, unskilled, unfit and incompetent persons, and to secure the services of persons having a practical knowledge of the construction of buildings; and it would seem that the qualifications of the relator, as disclosed in his own affidavit, which is conceded to be true by not being denied, are of a high order, and that he is fully competent to pass upon the character and quality of all the material and workmanship which enter into the construction, altering and repairing of buildings of all kinds.
>
> It seems to me that his description of himself and of his qualifications pictures to the mind a practical mechanic, who is especially skilled in the art of building, and acquainted with the rules and methods observed, prescribed and pursued by those engaged in constructing, altering and repairing buildings of all kinds, and possessing the skill to apply those rules and to adopt and follow those methods. He is, according to the record, skilled in all the trades which have to do with the construction of buildings, and such a person, according to the Century dictionary, is an artisan, a handicraftsman and a mechanic within the meaning of the charter.
>
> The relator is clearly a "practical" mechanic, because he has devoted himself for several years to the actual work of drawing plans for, and the construction of buildings of various kinds. I am of the opinion that it is possible for a person without legs or arms to become a practical building mechanic, that it to say, it is not necessary for a person to perform manual labor with the tools of any special trade or occupation to become such a mechanic. If such a person is competent to devise, direct and supervise the construction of all kinds of buildings in all their parts, he is at once an artisan, a handicraftsman and a mechanic. If he does all these things he is a "practical mechanic" whether he has ever touched a tool of any particular trade or handicraft or not.

The Holman locomotive "speeding truck," which was tried on the South Jersey R. R. last summer, is the basis of a company, which is now soliciting subscriptions to its capital stock in the city of Philadelphia. The Holman truck is a Minneapolis invention, and may be accurately described as the old Fontaine locomotive with another story added.

The company's authorized capital stock is $10,000,000, and it is offering 5,000 shares of the stock to the dear public at only $25 per share. The only tangible basis for this capitalization which we can discover is the statement that the South Jersey R. R. Co. has ordered Holman trucks for two of its engines; the prospectus closes with the following sanguine forecast:

> "We venture the assertion that within ninety days from the day on which the Holman trucks are put into regular service on the South Jersey Railroad that more than ninety contracts for its use will have been closed."

We venture the assertion that any one who invests his money in any such scheme as this without consulting some reliable mechanical engineer deserves to learn wisdom in the school of experience.

In our issue of Feb. 11 we briefly commented upon the proposed Nebraska State Board of Engineers as being peculiar in requiring the secretaries of the board to do all the work. An esteemed correspondent from that State explains that the presence of the Governor, Secretary of State, and Attorney-General on this "Board of Engineers" is due entirely to the State Constitution of Nebraska. This constitution enumerates all the executive officers, and denies to the Legislature the right to create new offices. When it became necessary to have a railway commission, for example, one was formed out of the constitutional officers, and the real duties of the commission were performed by the secretaries of a State Board of Transportation; but the decisions of these secretaries were of no legal force without the confirmation of the board proper. In the same manner the State Engineer of Nebraska is officially the Secretary of the State Board of Irrigation, and the system extends to the secretary of any board having to deal with technical or special business.

Our correspondent is opposed to the bill in question, as inadequate and wrong in principle. But our apologies are due to Governor Holcomb, of Nebraska for the implied reflection upon his honesty of purpose in being willing to pose upon such a board of engineers. We learn that Governor Holcomb is strenuously opposing the bill, and if it is defeated it will be chiefly by his efforts. He is actively opposing the creation of any additional boards, for this or any other purpose, and advocates the necessary constitutional amendment. The State Constitution of Nebraska, in forcing such absurdities upon the State Government, as are here referred to, certainly stands in need of radical amendment.

The celebration of the 25th anniversary of the Stevens Institute of Technology, an account of which we give elsewhere in this issue, was a splendid success, upon which the faculty and alumni are to be heartily congratulated. In view of the position that the school holds in the estimation of engineers everywhere, and of the influence it has exerted upon the development of other American engineering schools, it seems difficult to realize that at the founding, a quarter of a century ago, it stood alone, as the only school in the world exclusively devoted to the professional training of mechanical engineers, and as an experiment in technical education, the success of which was by many engineers considered very doubtful. The success of the Institute in its chosen field has been so great, notwithstanding the fact that its endowment is meager compared with that of many younger schools, that we venture to say no other half million of dollars invested for the benefit of technical education has ever been so fruitful of benefit to the world. This benefit is not measured merely by the fact that 600 graduates have been fitted for positions in which by hard work they may earn a comfortable living, but by the character of the work the graduates are doing in advancing the world's material civilization. In our English exchanges we notice there is a great amount of discussion going on as to the value of "technical education," and the general tendency of the letters is to decry such education as of little value. Perhaps the writers of these letters are right from their standpoint, seeing technical education only as it exists in England, which we understand is a very different thing from what it is in the United States. It might open the eyes of some of the English objectors to technical education if they would study American methods. In this country there is no difference of opinion, among men of intelligence, as to the value of such an education as its best engineer schools afford to those who are intellectually capable of receiving it. There is no doubt whatever that no better use could have been made of the money left by Edwin A. Stevens for an "institution of learning" than the endowment of Stevens Institute.

Steel rail orders for export have been received to the aggregate of 100,000 tons. This includes sales of 25,000 tons each to the London & Northwestern and the London & Southwestern railways, and 11,000 tons for Japan. So says the "Iron Age" of Feb. 18, which remarks that "these sales will convulse the English iron trade and furnish proof that henceforth our steel manufacturers must be reckoned as an important factor in the world's markets." Nevertheless, the same paper, in its editorial columns, speaking of the Carnegie-Oliver-Rockefeller agreement, and the cheap ore supply which the Carnegie Company receives as its result, which has made the export of rails possible, says:

> To speak of this lease as foreshadowing a control of the steel markets of the country or of the world, is absurd, and it is equally ridiculous to assert that it is going to lead at once to a reduction of cost even approaching some of the figures current.

Possibly this means that the steel mills, after having reduced prices so as to secure 100,000 tons of foreign orders and 800,000 tons of domestic orders, will now advance prices to those who have not been in a hurry to fill their wants.

We reprint on another page an interesting paper by Mr. Roger Atkinson, Mechanical Superintendent of the Canadian Pacific Ry., describing an interesting process of dressing car wheels, which has been tried by his company and appears to deserve more general attention. The principle of the process is merely that of the well-known cold saw, but the rotating piece, instead of being a thin disk is a disk with a face of three or four inches width, and shaped to the form which it is desired to give to the finished article. It is said that by this process, chilled car wheels can have their treads turned at much less cost than by the grinding process, and it is claimed that the surface left by the machine is smoother than the surface of a ground wheel. Locomotive tires, journals and chilled rolls for rolling mills may also be dressed by this process, with advantages which are set forth by Mr. Atkinson.

STEEL COLUMNS AND ECCENTRIC LOADS.

Many of our readers will remember that a couple of years ago an extended discussion was carried on in our columns concerning the eccentric loading of cast-iron columns and the proper precautions to be observed. Our attention has been called to some recent designs of steel columns which are coming into more or less extensive use for buildings of steel framework, and which are open to criticism as respects their ability to sustain eccentric loads.

It is perhaps not always realized that a column in a building is under quite different conditions of loading from a column in a bridge truss. An

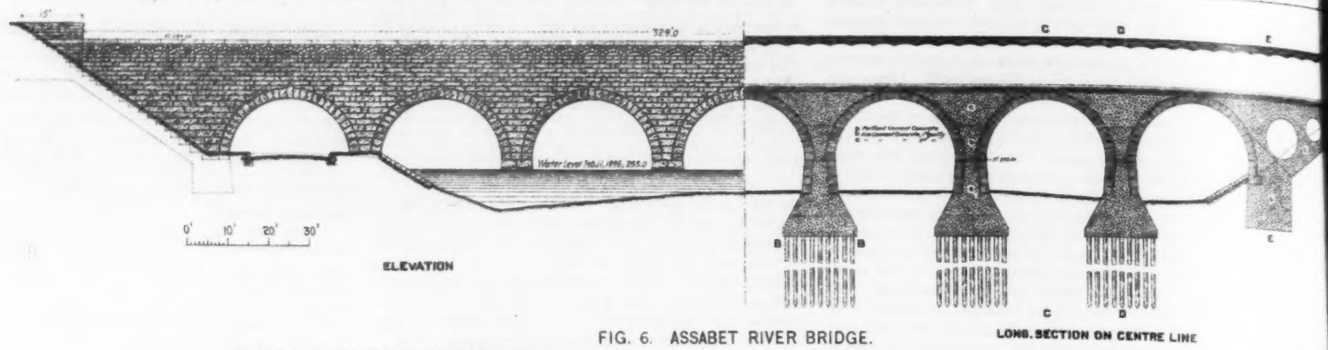


FIG. 6. ASSABET RIVER BRIDGE.

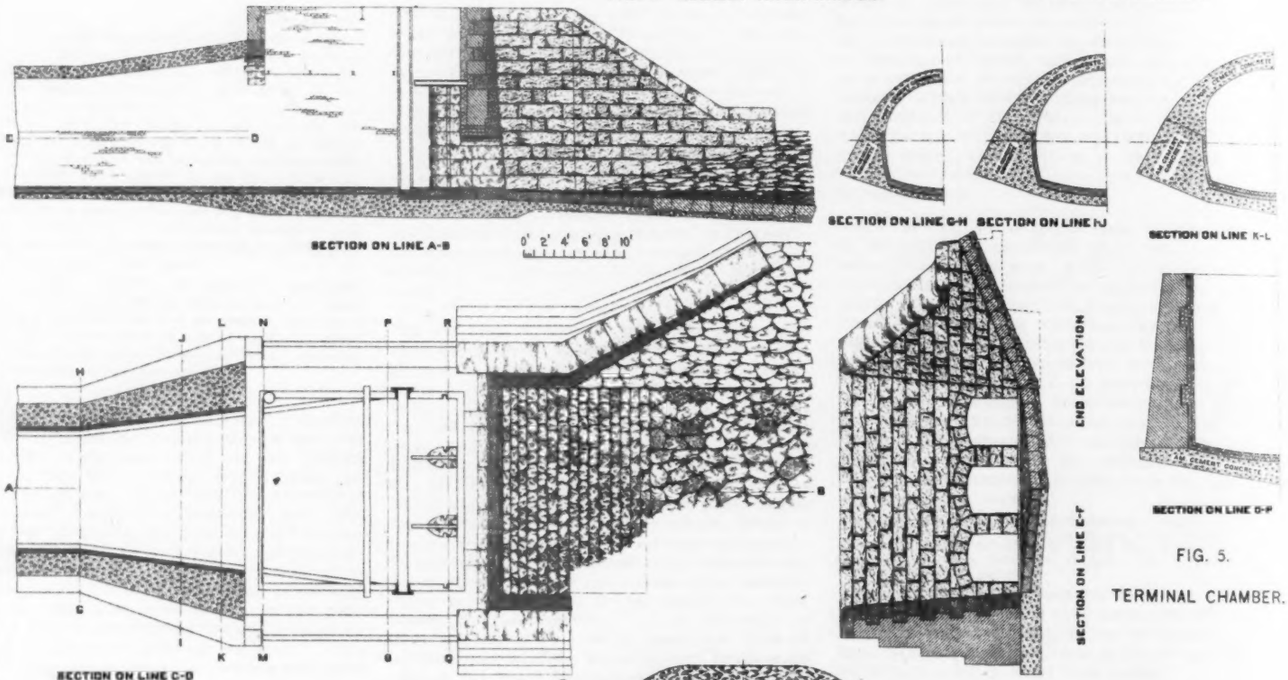


FIG. 5.

TERMINAL CHAMBER.

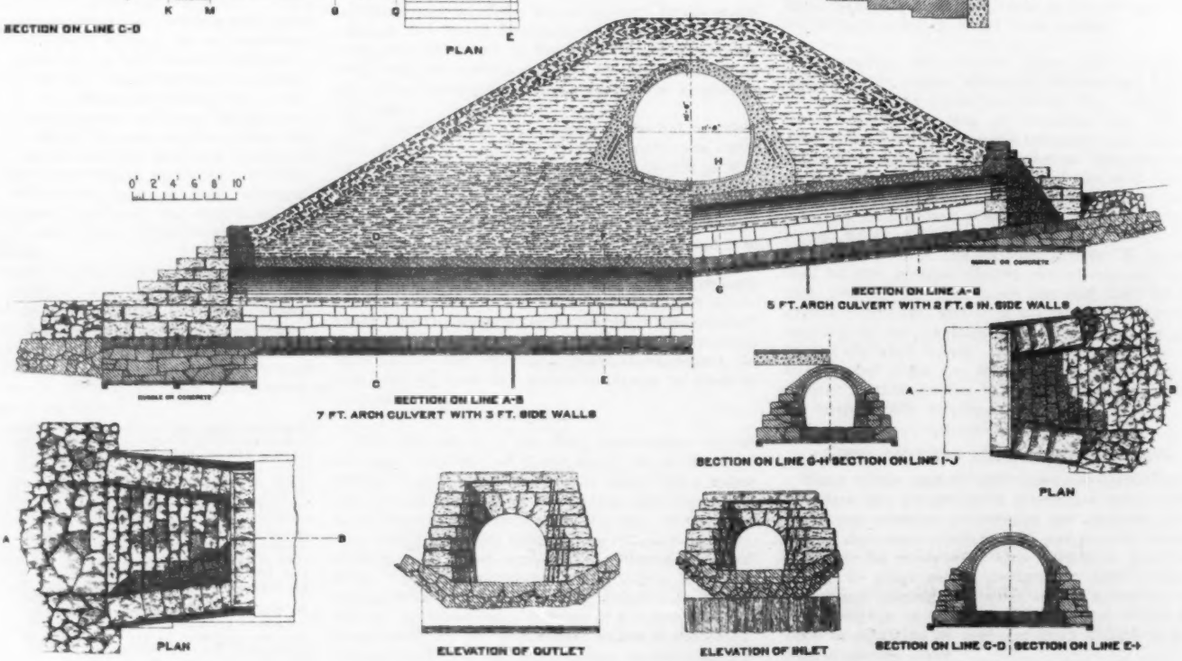

SECTION ON LINE A-B
5 FT. ARCH CULVERT WITH 2 FT. 6 IN. SIDE WALLS
SECTION ON LINE A-B
7 FT. ARCH CULVERT WITH 3 FT. SIDE WALLS
SECTION ON LINE G-H
SECTION ON LINE I-J
PLAN
PLAN
ELEVATION OF OUTLET
ELEVATION OF INLET
SECTION ON LINE C-D
SECTION ON LINE E-F

FIG. 3. ARCHED CULVERTS, 7 FT. AND 5 FT. DIAMETER.

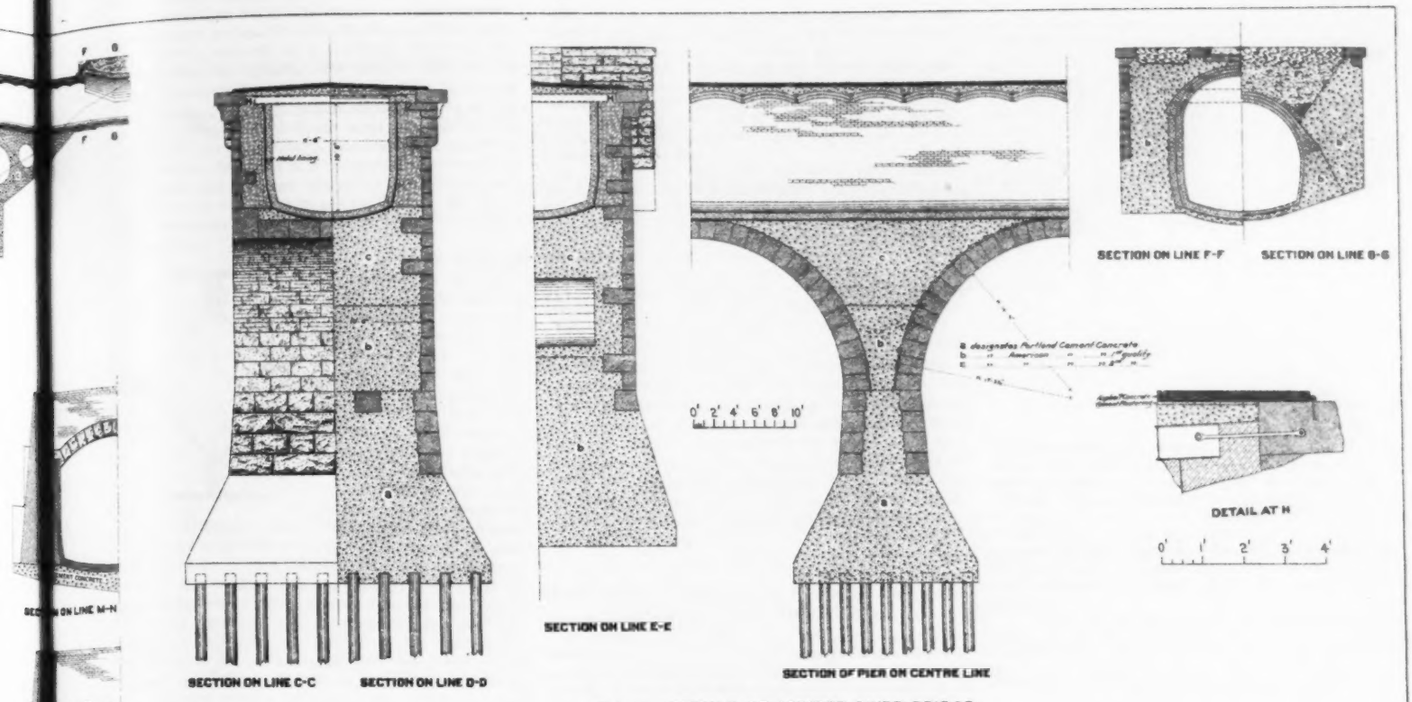

SECTION ON LINE C-C
SECTION ON LINE D-D
SECTION ON LINE E-E
SECTION OF PIER ON CENTRE LINE
SECTION ON LINE F-F
SECTION ON LINE G-G
DETAIL AT H

FIG 7. DETAILS OF ASSABET RIVER BRIDGE.

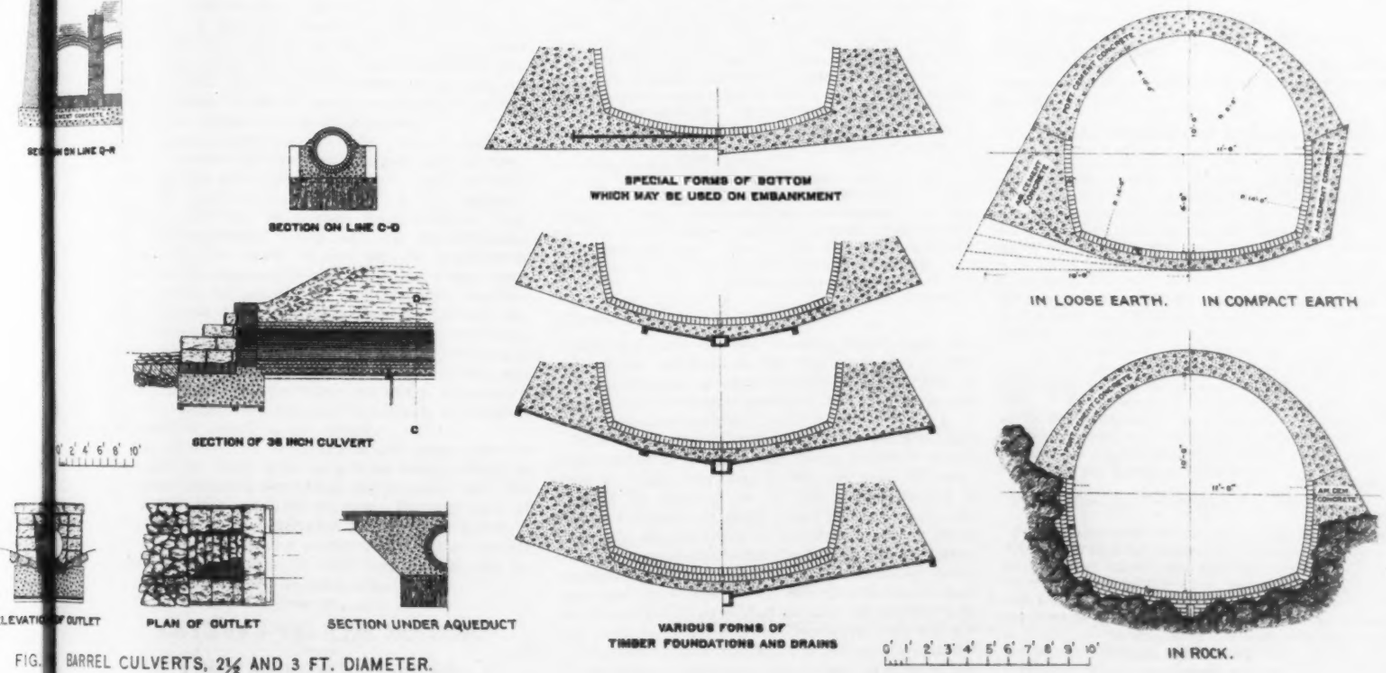


FIG. BARREL CULVERTS, 2½ AND 3 FT. DIAMETER.

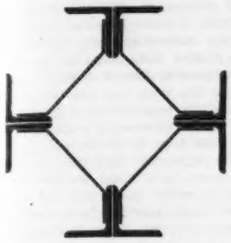
FIG. 1. TYPICAL CROSS SECTIONS; CLOSED AQUEDUCT.

NASHUA AQUEDUCT; METROPOLITAN WATER SUPPLY.

Frederic P. Stearns, M. Am. Soc. C. E., Chief Engineer,
Metropolitan Water Board, Boston, Mass.

CHAS. HART & SONS, LITH., 30 VESEY ST., N. Y.

upper chord member or a strut in the web of a bridge truss can be put in place, and the engineer can be fairly certain it will receive a central loading. With a column in a building, however, the engineer can be equally sure that it will not be loaded centrally, no matter how he may devise its connections. Even if equal girders meet it on opposite sides, one of them may carry a heavy load, while the other carries nothing but the dead weight of the floor. It is sometimes said that stiffness is an unimportant matter in a building column since its length is so short; but on the other hand this short length may be offset by its eccentric loading.



The Gray column, invented by Mr. J. H. Gray of Chicago is shown in cross-section in the accompanying cut. It is made up of four pairs of angles connected by bent tie plates, which we understand are usually 8 or 9 ins. wide and are spaced 2½ to 3 ft. c. to c. Suppose that in a building it happens that the floor girders on several successive floors are attached to one pair of angles. Then this pair of angles will carry most of the load. The tie plates have as their chief function to bring the stiffness of the other angles to restrain the overloaded angles from bending; they are too light and are spaced too far apart to be of much account in distributing the load carried by one pair of angles to the others.

Of course, where all parts of a column are loaded uniformly it may be made up of parts partially independent, without serious loss of strength. A familiar example is the end post of light highway bridges, which is sometimes made with short cover plates put on at intervals of two or three feet. But when a column must take eccentric loads, it should never be forgotten that it should be designed to resist bending.

The Larimer column, made by Jones & Loughlin's, in another column which is open to some criticism on the same grounds as the Gray column. The two members which make up the Larimer column, however, have each more stiffness than the pairs of angles which make up the Gray column, and the union of the two is continuous. Some of the types of Z-bar columns are also open to criticism on account of lack of unity between the different members which make up the column, the connection between the opposite Z-bars being made by tie plates spaced three or four feet apart. In any such case the amount of load which will be transferred to the other members that make up the column in case one member is overloaded is purely a matter of guesswork.

The aim of the designers of all these columns appears to have been to get as much metal as possible near the outside of the column; and this of course is a valuable feature. But any gain of this sort will be purchased at too great a cost if it involves weakening of the union of the various parts of the column so that they do not act together to resist the imposed load.

LETTERS TO THE EDITOR.

A Heavy Rainfall at San Diego, Cal.

Sir: The enclosed clipping from the San Diego "Sun" of Dec. 28 last, may be of interest and worthy of engineering record as an authentic account of rainfall in a dry country. It is curious to consider what might be the result of long continuance of such a phenomenal rain. For instance, the rate of 0.19 in. per minute would produce 11.4 ins. per hour, 273.6 ins. or 22.8 ft. per day, and 8,322 ft. per annum, or over 1.5 miles in depth! This must have been about the way it rained in Noah's time.

Yours truly,
James D. Schuyler.

Los Angeles, Cal., Feb. 5, 1897.

(According to the clipping sent, the rain began falling at 12:20 m., and at 1:20, or in just an hour, 0.82 in. had fallen. In five minutes of the time, 0.35-in. fell, and over half of that, being the 0.19-in. discussed by Mr. Schuyler, fell in one minute.—Ed.)

A New Black Printing Process.

Sir: Noting the correspondence on black-printing processes in your issues of Jan. 21 and Feb. 11, I beg to enclose herewith samples of the work done by Mr. F. Le Clere, of 21 North 13th St., this city. Mr. Le Clere's process is a secret one, and he has as yet not perfected arrangements for the manufacture of his paper on a large scale, or for its sale, and is therefore limited for the present to making prints from such tracings as are sent to him for the purpose.

As you will see, the prints are made upon excellent drawing paper, which is not affected by the process, and the work is scarcely, if at all, distinguishable from the best India ink drawings, the prints being actually black on white, not purple or gray, as is the case with most of the so-called black-printing processes in use. Some of the prints enclosed are a year or two old, and, so far as I know, the work is entirely unaffected by time or exposure.

Yours truly, John C. Trautwine, Jr.

257 So. 4th St., Philadelphia, Pa., Feb. 16, 1897.

(Mr. Le Clere calls these "Anthracene" prints, and says they are all made by a rapid photographic process. It is to be hoped that he will speedily place this paper upon the market, for the prints sent us certainly exceed anything we have ever seen in the whiteness of the paper itself and the sharpness and deep black of the printed lines. They are practically equivalent to pen drawings on good drawing paper, and could be amended, colored or directly reproduced by photographic methods with ease.—Ed.)

Water Power Development at St. Mary's Falls.—Cost of Railway Freight Transportation.

Sir: In your issue of Feb. 11 (p. 92) on the water power development at St. Mary's Falls, I notice that the company proposes to develop about 50,000 HP., taking the water through a canal three miles long, 300 ft. wide and 20 ft. deep, with a velocity of flow equal to 5 ft. per second.

Having recently been interested in a similar scheme, I was interested to estimate the probable loss of head in this canal. Assuming that $V = \sqrt{R S}$, I find that S in this case will equal .00039. This, for three miles, will give a loss of head equal to 6.2 ft., which, deducted from the 18 ft. fall in the St. Mary's River, will leave, say, 11.8 ft. as the effective head, which would in turn give 29,000 HP., instead of 50,000. It is probable a higher co-efficient could be used than 60, in which case we should have an increased effective head, but still I cannot see how we are going to get 50,000 HP.

I was also much interested in your comment on the Deep Water Ways Commission Report, in which you state freights are being transported by railroads for 7 cts. per ton mile, and I presume this is based upon a considerably over-capitalized cost. What would be the rates if the actual cost of construction were taken into account?

Respectfully yours,
James H. Harlow.

Pittsburg, Pa., Feb. 15, 1896

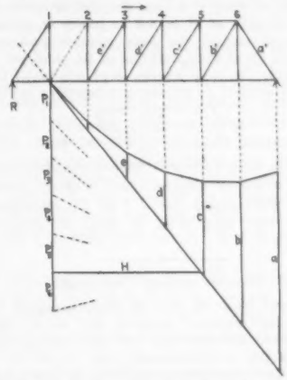
(Railway rates are not actually based upon the cost of the railways at all, and so as far as the freight shipper or the traveler is concerned it makes no difference whether the railways are over-capitalized or not.

In 1895 the total amount paid to stockholders and bondholders of United States railways averaged in round numbers $1,850 per mile of road. This is 5% interest on $37,100. What would it cost to replace at present prices for labor and material all the railways of the United States, with their terminals, real estate, buildings, rolling stock, floating equipment, and all the property of every sort that they now own? We do not know, and we are perfectly sure that no one else knows. Any one may have an opinion, however, and we are inclined to believe that $37,100 per mile would not be sufficient to duplicate the railway system of the United States. If this is true, then the owners of the railways are getting less than 5% interest on the average upon their investment. Of course there is a great disparity between different railways and between different sections of the country. Many railway lines have proved such bad investments that those who put their money in them are getting no return at all, and are not likely to. —Ed.)

A Graphical Method of Computing Bridge Strains.

Sir: For the purpose of verifying calculations of reactions and strains produced by moving loads, the following short and easy graphical method may be found useful in many cases.

In the diagram, the truss is supposed to be loaded at the panel points. A force polygon composed of these panel loads, P_1 P_2 and so on, is drawn to any convenient scale. If the pole "H" be made equal in length to the span S, (using the scale of feet) the successive reactions at the left abutment produced by the loads moving in the



direction of the arrow, are at once given by the intercepts a, b, c, etc., of an equilibrium polygon, measured by the scale of forces and not, as usual, by the scale of feet.

Proof: $H \times a$ = moment of loads about right abutment $= R \times S$ $\therefore$ $H \times a = R \times S$. Since $H = S$ we have $S \times a = R \times S$, i. e., $a = R$, or intercept "a" is the reaction of loads at left abutment, intercept "b" the reaction when loads have moved one panel length, "c" the reaction when they have moved two panel lengths, etc., toward the right abutment.

In trusses where the inclined web members have the same secant, the intercepts a, b, c, etc., will give the maximum live load strains in a', b', c', etc., respectively, if the pole "H" be made equal in length to $\frac{S}{\text{sec.}}$

For, since $H \times a = R \times S$, if $H = \frac{S}{\text{sec.}}$ then $\frac{S}{\text{sec.}} = R \times S$, therefore $a = R \times \text{sec.}$ = strain a' ; $b = R' \text{ sec.}$ = strain in b', etc., produced successively as loads move toward right abutment.

R. H. Bullock.

Engineer's Office, Plant System of Railways, Savannah, Ga., Jan. 25, 1897.

Checking Multiplication by Excess of Nines.

Sir: In your issue of Feb. 18 Mr. Steger expresses surprise that the method of checking multiplication by the excess of nines is not more common. One reason is that it is not an absolutely reliable check, and it is evidently somewhat unsatisfactory to use methods for checking which may in some cases give the answer as correct when it is really wrong. The case in which the method fails is evidently when two of the digits are wrong while their sum remains the same. For instance, if one of the digits is 3 greater than it should be and another is 3 less, the method of casting out the nines will show the result to be correct, while it is evidently wrong. As this involves two like errors of opposite signs, it is not likely to occur very often, but as there are only nine digits the occurrence is by no means a remote one. The best absolute check for multiplication or division is, of course, the reverse operation, as it involves entirely different figures, because the smaller number is usually used as the multiplier and the divisor. Yours truly,

Carl Hering.

927 Chestnut St., Philadelphia, Pa., Feb. 19, 1897.

Sir: In your issue of Feb. 18, p. 105, Mr. A. M. Steger refers to a familiar method of "Checking Multiplication by Excess of Nines" and says that the excess of 9's in the multiplicand multiplied by the excess in the multiplier will give an excess equal to that in the grand result "if the work is correct." This is true. But the difficulty is that this may be true when the work is not correct; and the fact is, there are cases which may, and do, arise in practice in which the method will not show whether the work is correct or not. And this is probably the reason why it is not more generally used. It will fail:

(1)—If the operator makes the product 9 or any multiple of 9 too great or too little; for in that event the excess of 9's, or remainder will remain unchanged, the quotient only being different from that obtained when the work is correct. It will also fail.

(2)—When the figures of a product are in any way transposed; as, writing 75 for 57, 910 for 901, etc., for it is obvious that the value of the number will be changed with every transposition of the figures (when they are of different unit values), while the sum of the digits will not be, and of course the excess of 9's will not.

This second source of undiscoverable error is practically only another form of (1); for when the digits of a number are not alike, any transposition of them will result in a number which will be 9 or some multiple of 9 greater or less than the given number.

It is conceded that the probability of an operator mak-

ing both, or either, of the above named mistakes is not exceedingly great, but the fact remains that if he does this method of checking is without value.

The method of checking by casting out the 11's is similar to that of casting out the 9's, but is more reliable; because a mistake of 11 is not so likely to be made. If both tests be applied the only possible undiscoverable error will be 99 or some multiple of 99. And yet the fact that any error can exist undiscovered will make the careful operator hesitate to rely upon a defective method.

Very truly yours,
A. M. Scripture, Assoc. M. Am. C. E.
841 Genesee St., Utica, N. Y., Feb. 20, 1897.

(We have also received letters making substantially the same criticisms from Messrs. Sidney B. Cady, of Bloomfield, N. J.; S. P. Bartholomew, Hazleton, Pa.; and Geo. E. Key, of Ann Arbor, Mich.—Ed.)

Honesty Among Engineers.

Sir: In your issue of Jan. 28 there appeared "An interesting correspondence" between Mr. E. H. McHenry, Chief Engineer, No. Pac. Ry. Co., and the Southwestern Construction Co., of Kansas City, Mo.

I, with other subscribers, expected to see some comments on the correspondence in the succeeding issues of your paper, but it seems that no person attaches importance enough to the case to talk about it.—(A letter commenting upon it was published in our issue of Feb 11.—Ed.)

As a contractor, I beg to offer a few remarks thereon. All honest contractors will endorse Mr. McHenry's action in the matter, without doubt. If all engineers were like Mr. McHenry, honest contractors would come nearer getting their dues when bidding on work. Many contracts are taken nowadays at prices apparently below any possible cost, when the estimates are based upon certain fixed requirements and specifications.

The crooked contractor takes work below the honest contractor's cost, providing he can obtain the assistance of crooked officials to help him "out of the hole." If he fails in obtaining the necessary assistance, he remains "in the hole." If he has money, he then loses it. If he has no money, some one else loses it.

The Southwestern Construction Co. makes a very broad and sweeping statement when they say that "Mr. McHenry must stand alone in his class." Maybe he does, so far as their personal experience is concerned; but we can safely assume that their experience is not as broad as their statement. However, Engineering News can do a great favor to engineers and contractors alike if it will furnish the names of the various railways or corporations for which the Southwestern Construction Co. has been doing work.

Maybe other contractors have failed in their efforts to obtain a chance to bid on the work of such roads or corporations, but not from the same cause that barred the Southwestern Construction Co. from bidding on the Northern Pacific work.

The results of the "publication" may or may not be a punishment. There is sometimes a ridiculous and amusing side to such matters. Let me illustrate by relating an actual occurrence of 22 years ago.

A certain bridge company sent its agent to bid on a large highway bridge. The agent found strong odds against him, and wrote his superiors for advice. The company wrote back that a proper amount of "the long green," judiciously placed where the proper officials would find it, would do more toward securing the contract than all the chin music that he could grind out." Unfortunately (?) the agent lost the letter of advice. It was found by the agent of a rival concern, who immediately had several hundred copies printed and distributed all over the country so as to warn the "unsuspecting agriculturalists" (who filled the county offices) against those bad persons, and thereby run them out of the business; but, strange to relate, an unprecedented wave of prosperity soon overtook the bad company, and for several years afterward they did a thriving business, often obtaining contracts at higher prices for lighter work than all competitors, and they still continue in business at the "old stand," overreaching all competitors in some localities and more particularly in the territory close to where the Southwestern Construction Co. resides. This will be recognized as an actual fact by many of the old timers in the business.

Now it remains to be seen whether the Southwestern Construction Co. will suspend business or enter upon a long period of prosperity. Yours truly,

C. E. H. Campbell.

Council Bluffs, Iowa, Feb. 16, 1897.

The Nicaragua Canal Bill.

Sir: I do not, womanlike, expect to have the last word, but must remark that your comments on my letter published in your issue of Feb. 11 are an evasion, not an answer. That, as a pronounced friend of the Canal you very strangely brought into prominence, by publication, articles attacking the Canal as a project, not its surveys or demands for surveys. That these papers will howl louder on the Monroe doctrine, etc., if the foreign capitalists, whose engineers at various times reported favorably on the project (in contrast with the Commission's report), should build the Canal, and thus the control be in danger of passing to another nation. That the concession lapses in a few months.

That in your "role" as watch-dog of the Treasury you can find a party of engineers of thorough technical training, acquainted with the country and its former surveys who are anxious to undertake and guarantee to carry out all the work recommended by the Commission, for one-tenth the amount they wish appropriated. That the Commission's report is not the only one by an unbiased board of engineers of unquestionable integrity, and on one of these an Editor of the News served. "Ergo," engineers are a delusion to their employers. That I can attest your fairness and my appreciation of the News after twelve years as a subscriber. Finis. Yours truly, Boyd Ehle.

Tonawanda, N. Y., Feb. 13, 1897.

(We said in our issue of Jan. 28 that the course of the Nicaragua Canal promoters in attempting to force the bond guarantee bill through Congress had made enemies for the enterprise itself, and we published the newspaper extracts, to which our correspondent objects, to prove this, stating plainly that we did not by any means agree with all their statements.

Concerning the "control" of the completed canal, it will have to be neutralized by international agreement like the Suez Canal, no matter what nation builds it.

We do not favor the policy of letting engineering work of any grade to the lowest bidder; and where the question is as to the approval of estimates for an engineering work involving an expenditure of a hundred million dollars, it would be the height of spigot-saving economy to be niggardly in paying the engineers who are to pass upon the question. The Nicaragua enterprise in all its details should be reviewed by a commission made up of men at the head of the engineering profession. They should be furnished ample funds for the employment of a capable staff, and they would deserve to be paid as liberal sums for their opinions as an eminent lawyer or jurist would receive for an opinion upon a legal question involving an equally large amount.

We might answer our correspondent's letter in much more detail; but rather than take the space to do so we print the following letter, which we received in the same mail as his own.—Ed.)

Sir: I think the thanks of the community are due to you for the stand you have taken in regard to the proposed Nicaragua Canal; all the more commendable from the fact that, as the foremost exponent of the engineering interest in this country, it might have been feared that you would advocate, through thick and thin, the passage of the bill, on account of its prospective impetus to engineering enterprise.

There can be no doubt that we are about to enter upon a critical period of our commercial and industrial history, and at the dawn of reviving prosperity it is of the utmost importance to take no hasty and ill-considered steps. Once before, and recently, the country got drunk with prosperity, and did some foolish things when under the influence of this inebriety, only to wake up next morning with the consequent headache and accompanying good resolutions. Do not let us now beggar the promise of the future by plunging headlong into gigantic and ill-considered schemes. We want, or do not want, to set in motion the machinery of the Nicaragua Canal project precisely according to circumstances. If such a canal can be built for a reasonable and determinate sum, and an intelligent forecast shows that the advantages, commercial and political, will be commensurate, then we want the work to be commenced and carried through with calm determination under proper control and guarantee. If, on the other hand, it is to be forced upon the country, with bluster, buncomb and crazy recklessness of consequences, then we do not want to have anything to do with it. In a word, we do not want to commit this country to a repetition of the Panama fizzle.

You are simply dead right in your position, as I understand it, in this matter, and I believe you have the good sense of the country behind you. G.

Yonkers, N. Y., Feb. 13, 1897.

A NEW METHOD OF DRESSING CAR WHEELS, AXLES, ETC.*

By R. Atkinson, M. Can. Soc. C. E., Mech. Supt., Canadian Pacific Ry., Montreal, P. Q.

The working of iron in the cold state by means of machinery to cut or dress it has largely supplemented the art of working hot iron for more than a century, and has been the only known means except the grindstone for dressing or finishing iron and its various alloys until [illegible] years. The greatest departure from the work of the grindstone was probably made by the introduction of the emery wheel, which differs from the grindstone in being revolved very rapidly, and therefore in doing more work in the same time, thereby replacing time by power; but, on the other hand, it is like the grindstone, in that it loses much more of its own substance than it removes from the material operated upon. A further advance was made in the art by the introduction of the blind saw for cross cutting bars of iron or steel, such as rails, etc., in the cold state. In its operation, the most notable feature is, that less of the operating material is displaced than is removed from the material operated upon, even though the latter is the harder substance.

The Sibbald machine and process, which was primarily intended for dressing journals or other forms of finished work, appears to be a further distinct advance, inasmuch as the effect is not only to remove more metal in a given time, but also to leave the surfaces so dressed in more perfect state than heretofore for the work they are intended to perform. Such a machine has been built and operated in actual commercial form in the presence of some members of this society, but it has been developed still further in England after more experience and with better source of power, under instructions from its present owners. The first occasion on which the writer had the pleasure of seeing the first crude machine in operation was in May, 1886, at the works of Mr. W. G. Miltimore, at Arlington, Vt., when it was used to dress cast-iron car wheels. A heavier and improved machine was afterwards built by J. Laurie & Bro., of Montreal, under the direction of Mr. W. C. Farnam, and operated in a shed at the old Canadian Pacific Ry. works at Hochelaga.

A description of the machine may be given as follows. A ring about 33 ins. diameter, of mild steel (about 0.65% carbon) is fixed like the tire of a locomotive driving wheel on a suitable center, which is mounted on a heavy shaft, and has its periphery turned to the proper profile on the wheel to be operated upon, and very carefully balanced. The disk thus formed is driven at a speed of about 3,000 revolutions per minute. The wheel is set in a suitable carrier and is revolved slowly, about two or three revolutions per minute, so that the surface when brought against the operating disk will move in an opposite direction. The wheel and disk are then pressed together with a force sufficient to cause friction enough to consume a great part of the power which is driving the disk and thus convert the power into heat. The disk cuts or rubs off the metal of the wheel operated upon, and leaves a smooth finished surface, which by the pressure and heat is closed and hardened to a considerable degree and to a depth of 0.01-in. or more, depending on the grade of the steel worked upon.

The principal constructive feature in the machine itself is the manner in which the friction on the journals of the disk which would result from the combined great pressure and high speed, is overcome by a system of forced lubrication, carried out by pumping oil into the bearings at the point of contact, thus causing the shaft to revolve upon a film of oil which flows out at the ends, where it is collected by centrifugal force and returned to the pumps.

In the latest form of this machine as operated at the works of Easton, Anderson & Goolden, Erith, England, it was found that by sending an electrical current through the point of contact of the fusing disk and wheel, so as to heat the wheel at that point, a very great reduction in the power could be made, or much more material removed by the same power in a given time. The following extract from a report made by that firm will explain this fully:

The reason why the disk cuts metals harder and tougher than itself is apparent when the operation is analyzed. The mechanical equivalent of heat, as demonstrated by Dr. Joule and others, equals about 42 units of heat per HP. per minute, thus giving at the periphery of the disk a heating effect directly in proportion to the horse power applied, as all the net power delivered to the disk is converted into heat by frictional resistance and disturbance of metal under operation. As the power is consumed and the heat generated where the disturbance of metal under operation takes place, it follows that a greater part of the heat is generated in the metal being removed. The disk being kept cool by conduction and radiation into the atmosphere, or by application of water, its surface is not disturbed, and consequently very little heat is generated within the disk. The higher velocity of the disk, viz., 33,000 ft. per minute, requires only 1 lb. frictional resistance to the movement of the disk per horse power applied. Thus in the consumption of 100 HP., 100 lbs. frictional resistance to the movement of the disk is given; this distributed over the surface of contact between the metal under operation and disk, which exceeds 1 sq. in. at all times, is not sufficient to abrade or injure the surface of the disk. With 100 HP. (net), we have a total heating capacity of 4,200 calories or English units of heat per minute, equal to raising the temperature of 4,200 lbs. of water 1° F., and as the specific heat of steel is 0.12, it follows that this horse power will raise the temperature of 35,000 lbs. of steel one degree; this equals 14 lbs. heated to 2,500°, the temperature to which steel is heated in removal by this process. The percentage of the total heat equivalent to the net power delivered to the disk which is utilized in actual work is indicated in the last column of the accompanying report of a test made at Erith Iron Works, April 6, 1892.

The report alluded to in the above extract was made by Mr. Dickinson, C. E., of Messrs. Easton & Anderson, and is appended to this paper.

*Read before the Canadian Society of Civil Engineers, Jan. 7, 1897.

It may therefore be assumed, allowing for the difference in cost of labor, that 15 cts. per wheel would be ample allowance even for removing the large amount of 16 lbs. per wheel. This would give 60 wheels in a day of 10 hours. The output of an ordinary wheel lathe is from 1½ to 4 pairs per day, depending upon the work necessary and the build of the machine. The number of cast-iron wheels which may be dressed per day is so variable that it is almost impossible to form an estimate of the average, depending as it does upon the conditions of the wheel.

Questions have often been asked as to whether any damage could result to the cast-iron wheel, but the writer cannot say that there is any probability of damage occurring.

The writer had occasion to inspect a pair of second-hand cast-iron wheels which had been dressed to remove flat spots about 2 ins. diameter, and after being replaced in service had been run 14,000 miles until worn through the clear chill, and began to show the mottled metal beneath, and were then still in good condition as to shape and surface. From this inspection the writer would say as follows:

1. Since the pressure of the disk is less than the load when in service, and all the shocks of service are avoided, it is manifestly impossible for the pressure during the operation of dressing to be in any way detrimental to the body of the wheel.

2. The wheels in service showed no defect or disintegration of the chill whatever, and are in no way to be distinguished from other wheels (not dressed) in any respect except superior form.

3. The writer has not seen any steel-tired wheels in service which had been dressed on this machine, but he is strongly of the opinion that not the slightest cracking or peeling off can possibly take place—in fact, he views it as utterly impossible, since he has had pieces broken out of steel tires repeatedly without any indication of such defect.

The economic value of this machine lies in substituting power for time, and the saving depends of course upon the cost of power. What this cost should be has been the subject of much discussion, but in the writer's opinion a well-designed steam plant in favorable locality should develop 1 HP. for 1 ct. per hour.

Appendix.—Gain by the Use of Electricity.

It is indicated by experiments at Erith Iron Works and elsewhere, that a greater heating efficiency can be got from the electrical current applied at points of contact between the heating disk and the object being dressed, than from the power frictionally consumed, and that considerable saving can be made by applying a large percentage of the power electrically, sufficient power only being applied to the disk to remove the metal heated by the electrical current. The effect of the current upon the disk is not destructive owing to the distribution over its whole peripheral surface, and as the current is passed through the heated spot in the metal under operation, where the greatest resistance takes place owing to high temperature and small surface, we consume most of the current within the body of the metal being removed, consequently the higher percentage of efficiency. The current applied in very small quantities appears to greatly increase the co-efficient of friction, and thus less pressure between surfaces is required to consume the power and generate its equivalent in heat; consequently a gain is made in reduced frictional resistance throughout the journal bearings of machine, in addition to the heating effect of current.

The gain in mileage life of car wheel tires hardened by this process over those in ordinary condition (as indicated by the greatly reduced wear of tires dressed by this process and the increased durability of chilled iron wheels over those of soft iron) must be great, and if the advantages of this process are fully utilized by redressing soon after the hardened surface is worn off, the mileage life of ties will be at least doubled. The cost of dressing when only sufficient metal is removed to reproduce the hardened surface will be considerably less than is shown in the report of tests made April 6, 1892, at Erith Iron Works.

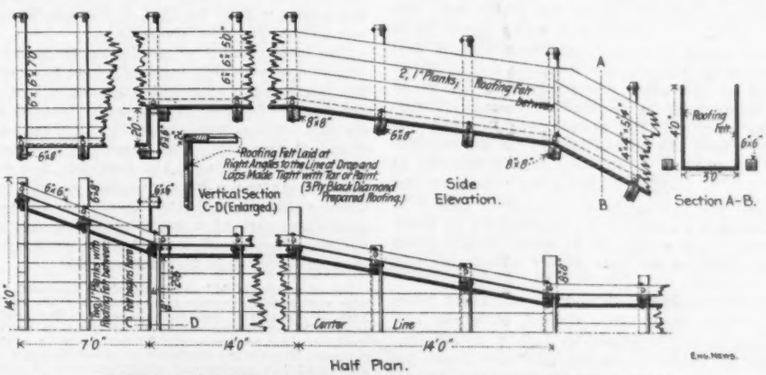
In addition to the dressing of railway wheel tires, the process is peculiarly well suited to the finishing and hardening of journal surfaces in all classes of machinery where journals are subjected to considerable pressure and speed. The journals of railway axles are rendered very much more durable, and will give proportionately less trouble when dressed and hardened by this process.

It is only necessary in dressing journals to remove a small amount of stock, 1-32-in. being quite sufficient to harden the surface, and this does not distort or spring the journal, as is the case where journals or spindles are case-hardened or tempered throughout, although the surface produced by this process is much harder, more dense, and in every way more perfect than is possible to get from any other method of hardening. Milling rolls of suitable steel (which may be softly annealed if desired) may be dressed, and a surface produced much harder and more durable than that of chilled iron; rolls of chilled iron can also be most economically dressed by this process, when electrical current is used to increase friction, and heat metal being removed. The expense of hardening journals by this process is slight, as very little metal is removed.

The report of car wheel dresser trials, with and without the electrical current, is entirely based upon observations and data made by two competent experts, acting quite independently of each other in taking observations, and indicator cards alternately throughout the trial. The reports from each expert were made independently, the result showing only a very slight percentage of difference between the two. The conclusions in footnote of report are entirely based upon actual results attained during these trials; and as a trial machine is very imperfect in many essential points, it is expected that a much higher percentage of efficiency can be attained with the proposed new machine, although this is not assumed or indicated in the report.

ROOFING FELT AS A LINING FOR IRRIGATION FLUMES.

In place of the usual calking where it is desired to secure a water-tight flume, Mr. Elwood Mead, M. Am. Soc. C.E., State Engineer of Wyoming, has been using a lining of roofing felt on all work done recently. He states, in a letter to this journal, that it seems to be "an unqualified success, securing a water-tight structure without the calking which has always been such an annoying feature in this work heretofore."


2, 1" Planks, Roofing Felt between
Roofing Felt Laid at Right Angles to the Line of Drop and Laps Made Tight with Tar or Paint. (3 Ply Black Diamond Prepared Roofing.)
Vertical Section C-D (Enlarged.)
Side Elevation.
Section A-B.
Roofing Felt
Center Line
Half Plan.

ROOFING FELT FOR LINING A DROP FLUME ON THE CODY CANAL.
Elwood Mead, M. Am. Soc. C. E., Cheyenne, Wyo., Consulting Engineer.

The manner in which the felt is applied is shown in the accompanying details of a drop flume on the Cody Canal, for which Mr. Mead was consulting engineer.

The illustration is part of a sharp drop on the Cody Canal, where the natural surface of the ground falls 72 ft. in 220 ft. The flume has its top, for most of the distance, about at the ground surface, changing in grade several times, and on one horizontal stretch of 100 ft. dropping about 50 ft.

Car Wheel Dresser Trials With and Without the Electrical Current; Erith Iron Works, England, April 6, 1892.*

Condition of trial.	I. HP. Total.	I. HP. Net including 2 E. HP. for c'r'nt.	Reduction by using elect'l c'r'nt.**	Steel removed per HP. per min. cu. ins.	100 I. lbs.	Efficiency of machine.*	Revolutions per min.	Remarks.
1. Engine only	27.56	.....	..	.....	....	....	3,168	
2. Engine driving disk	67.36	.....	..	.....	....	....	3,276	Running light.
3. With current	104.86	39.5	24%	10.92	3	21.4%	3,150	Cut ⅛-in. deep; traverse 3 ins. per minute.
4. With current, mean.	110.66	45.35	13%	9.35	2.61	18.6%	3,123	Diameter of wheel, 36 ins.
5. Without c'r'nt, mean.	119.57	52.21	..	8.11	2.27	16.2%	3,141	Same feed as in 3 and 4.
6. Without c'r'nt, mean.	.....	.....	..	.....	.....	....	3,132	Same feed as in 3 and 4.

*The efficiency of the machine indicates the percentage of work equivalent to the heat generated at disk to the net HP. delivered to the disk. With the proposed new machine and engine indicating 166 HP. = say 100 I. HP. net, 6 wheels per hour could be dressed, removing 16 lbs. from each. Allowing 40% of total time for handling wheels, etc., the mean I. HP. with machine at constant work being 125, and the estimated cost per wheel, including 1½ lbs. coal per I. HP. per hour, fireman $6.25, machine attendant $7, per week each, and interest and depreciation on plant of $450 per annum, being 10½ cts. per wheel.

**In net I. HP. over mean of Nos. 5 and 6.

THE STEVENS INSTITUTE CELEBRATION.

A notable event in the history of engineering education in the United States was the celebration of the 25th anniversary of the Stevens Institute of Technology, which was held on Feb. 18 and 19. The exercises included a banquet at the Waldorf Hotel, New York city, an exhibition of work accomplished by the professors and by the alumni during the last 25 years, a reception given by Mrs. Martha B. Stevens, widow of the founder of the Institute, at her residence, Castle Point, Hoboken, N. J., and a promenade concert and ball. All of these were well attended, and the eclat and enthusiasm were all that could be desired. Several class reunions were held, and many old graduates revisited the Institute for the first time in many years.

The foundation of the Stevens Institute was the result of the munificence of Mr. Edwin A. Stevens, of Hoboken, who in his will dated in 1867 bequeathed to trustees for the establishment of an "institution of learning," a large block of ground located near his residence, $150,000 for the erection of a building upon it, and $500,000 as an endowment fund. Upon his death, in 1868, the three trustees, Mrs. Stevens, and Messrs. W. W. Shippen and S. B. Dod, decided that the new institution should be a "school of mechanical engineering," and thus they began the first school in the world specially designed for the professional training of mechanical engineers. Such a school they deemed was not only greatly needed at the time, but it would also best perpetuate the name of the Stevens family, which had been noted for three-quarters of a century for its distinguished mechanical engineers. The elder John Stevens, born in 1749, graduated at Columbia College in 1768, and was admitted to the bar, but did not practice. He devoted himself to the problem of navigation by steam, and as early as 1789 he presented a memorial to the New York Legislature, stating that he had perfected his plans. He took out a patent on steam propulsion in 1792, and experimented continually till 1804, when he produced and successfully ran the first steam vessel driven by a screw, the steam being furnished by a high-pressure water tube boiler, also of his invention. This was three years before Fulton with his English engine, built by Watt, ran his paddle-wheel boat, the "Clermont," on the Hudson River. In 1808 Stevens built the "Phoenix," which was the first steam vessel navigated on the ocean, making the trip from New York to Cape May, thence by river to Philadelphia, thus making the first journey by steam between the two cities. Charles King, president of Columbia College, writing of John Stevens in 1852, said: "Born to affluence, his whole life was devoted to experiments at his own cost for the public good," and the same may be said in substance as to his sons, Robert L. and Edwin A. Stevens.

Robert L. Stevens, the elder son, was associated with his father in experiments on steam navigation from 1804 onward. In 1808 he himself took the "Phoenix" from New York to Philadelphia. In 1811, with his father, he established the first steam ferry in the world, between Hoboken and New York. From 1815 to 1840 he stood

at the head of his profession as a constructor of steam vessels in the United States, making innumerable improvements which were generally adopted. In 1812 he urged the construction of a railway on the line afterwards occupied by the Erie Canal. In 1815 he obtained the first railway charter granted in America, for a line between Trenton and New Brunswick. In 1823 he secured acts of the legislature of Pennsylvania incorporating the Pennsylvania R. R. Co. In 1826 he constructed a locomotive with a multitubular boiler and ran it on a circular track on his own grounds at Hoboken. In 1830, with his brother, Edwin A. Stevens, he obtained the charter for the Camden and Amboy R. R., in New Jersey. They opened the road in 1832, and operated it for many years. In 1830 he devised the T rail, now universally used in the United States, and went to England to have it rolled, personally superintending its manufacture. The first shipment of these rails arrived in Philadelphia in 1831, and over 30 miles were laid before the summer of 1832. Towards the close of the war of 1812 he was engaged in making a bomb that might be fired from a cannon instead of from a mortar, and with his brother Edwin succeeded in producing a percussion shell, which was adopted by the government. In 1812 John Stevens made the first experiments with artillery against armor, which were continued by his sons in 1840. In 1842 they secured a contract from the government for an iron-clad vessel with plating 4½ ins. thick. The vessel was continuously under construction and alteration for a series of years, the improvements in ordnance from time to time requiring an increase in the thickness of the plating, and consequently in the size of the hull. The "Stevens Battery," thus began, was a vessel far in advance of the time, and the improvements first introduced in her are now common to the battle ships of all countries. She was too far advanced to be appreciated by the naval commanders during the war, and the government declined the liberal offers made by her owners for her completion. Mr. Edwin A. Stevens left $1,000,000 in his will to be used in finishing the vessel, but by that time the development of ordnance had been so great that the sum was not sufficient to make the vessel strong enough to resist attack from modern guns, so she was finally abandoned and sold for scrap.

Edwin A. Stevens, born in 1795, was eight years younger than his brother Robert, in whose experiments and enterprises he was a co-laborer. In 1842 he patented the air tight fire room on steam vessels, now in use in all the navies of the world. He was not as famous for independent invention as were his father and his brother, but in leaving his wealth for the foundation of the Stevens Institute of Technology he did a deed of incalculable value to the world, and one which will cause his memory to be cherished by engineers in all time to come.

The trustees appointed under the will of Edwin A. Stevens erected the substantial college building in Hoboken, and called to their aid as President of the Institute Dr. Henry Morton, then Secretary of the Franklin Institute of Philadelphia and editor of its "Journal," who had already been distinguished as a physician, as professor of chemistry in the University of Pennsylvania, and as a popular lecturer. In the fall of 1871 the Institute was opened. The faculty consisted of Dr. Morton, president and Professors Alfred M. Mayer, physics; Albert R. Leeds, chemistry; Robert H. Thurston, mechanical engineering; Chas. F. Kroeh, French and German; Rev. Edward Wall, English and belles-lettres; Chas. W. MacCord, mechanical drawing; Lieut. Col. H. A. Haskell, U. S. N., mathematics and mechanics. The last named retired in a few months on account of failure of health, and he was succeeded by Prof. De Volson Wood.

All of these original members of the faculty who began the work of the Institute over 25 years ago still remain in it, except Col. Haskell and Prof. Thurston, the latter of whom about ten years ago resigned to become Director of Sibley College in Cornell University.

The number of students was small at first. One was graduated in 1873, three in 1874, eight in 1875, and seventeen in 1876. By that time the Institute had become well known and students began to crowd into it, constantly increasing the need for additional instructors and equipment. The original endowment fund of $500,000 was reduced $45,000 by the U. S. government collateral inheritance tax, a relic of the "war taxes," which was then still unrepealed. Except a bequest of $11,000 from Dr. Jacob Vreeland, of Poughkeepsie, N. Y., the income of which was designated to be used "for assisting indigent and deserving young men" in the Institute, the only additional endowment the Institute has ever received has been a number of contributions from President Morton himself. In 1881 he gave something over $10,500 for fitting up the workshop, in 1883 $2,500 for apparatus for the department of applied electricity, then established, and for its running expenses for two years; in 1889, $10,000 towards the endowment of the new chair of Engineering Practice; in 1892, $20,000 additional for the same object, and in connection with the present celebration he has just presented to the trustees 1,000 shares of stock of the Texas Pacific R. R., now depreciated below what is believed to be its real value, to be held to be used some time in the future as a contribution to a new building to be known as the "Alumni Building," for which the alumni have already contributed about $15,000.

In recent years the number of students in attendance has averaged over 200 and now numbers 260. Between 40 and 50 are graduated each year. The number of the faculty has increased to 22, nearly all the new members being graduates of the Institute. Prof. Wood succeeded Prof. Thurston in the chair of mechanical engineering, and his place in the department of mathematics and mechanics is filled by Prof. J. Burkitt Webb, who came from Cornell University.

The total number of graduates from the Institute is now over 600, most of whom have received the degree of mechanical engineer, a few taking the degree of doctor of philosophy instead, having devoted themselves especially to physical and chemical research. The degree of electrical engineer is not given by the Institute, but all students are given a very complete course in electrical engineering, which is considered to be a necessary part of a mechanical engineer's education. The record made by the graduates was thus summed up in November, 1895:

> Out of a total of 551 graduates there appeared to be 148 who were superintendents and managers of the entire business of important machine shops and like engineering works; 54 consulting engineers carrying on professional work on their own account; 30 professors in engineering colleges; 55 assistant engineers or superintendents in work shops and like mechanical establishments; 16 presidents, vice-presidents, secretaries and treasurers of manufacturing companies; 103 employed, under superiors, in designing, drawing and superintending the construction of machinery; 36 patent lawyers, solicitors, agents and inspectors for manufacturing companies; 8 superintendents of motive power on important railways; 13 in the employ of foreign corporations; 6 editors of engineering journals; 3 architects; 4 chemists; 50 unknown or unclassified; 25 deceased. Among the unclassified should be mentioned one who after graduation turned his attention to fine art, and who has been for many years hors concours at the French Academy and received in 1893 the decoration of the Legion of Honor. This is Mr. Eugene Vail, who in a recent letter to President Morton says: "I take the keenest interest in the welfare of my 'Alma Mater,' and although my career has been so different from that of most of my classmates, I shall never regret the four years spent at 'Stevens' or the training which has often been most useful in my after life."

The exhibition made by the faculty and alumni at the Institute on Feb. 19 was a genuine surprise even to the alumni themselves. There were no less than 98 separate exhibits, some of them containing several different articles representing work actually accomplished by the faculty and the alumni in the lines of original invention, design, construction, superintendence of construction, contributions to engineering literature, etc. From 10 a. m. to 5 p. m. the first floor and the basement were crowded with visitors. Many of the machines shown were in operation, their inventors or constructors being on hand to explain them. A catalogue was distributed giving particulars of the exhibits and their location, from which we take the following partial list. It gives a fair idea of the great variety and importance of the work accomplished by Stevens alumni:

Henry E. Abbey, '85, Multoscope, redesigned.
W. S. Ackerman, '91, Photos and sketch of white lead machinery.
Oscar Ants, '78, Drawings of compressed-air snow flanger.
C. G. Atwater, '91, Photos of coke ovens.
R. C. Ball, '95, Governor and tachometer.
Wm. O. Barnes, '84, Photos of steel type-engraving machine.
G. M. Bond, '80, Picture of standard measuring machine.
B. G. Braine, '93, Photos and drawings of R. R. coupler.
H. M. Brinkerhoff, '90, Photos of intramural and electric elevated railways.
W. H. Bristol, '84, Recording instruments for pressure, temperature and electricity.
B. B. Bristol, '93, Associate engineer with W. H. Bristol.
Morgan Brooks, '83, Drawings and patents.
E. Burhorn, '85, Plans for water-works, and photos.
W. S. Chester, '86, Photos of electrical outfits for church organs.
B. H. Coffey, '85, Photos of dredging machinery.
C. R. Collins, '86, Copy patent oil spraying device.
F. N. Connet, '89; A. A. Fuller, '88; W. W. Jackson, '89, Venturi meter, polishing lathe, photos of work.
F. W. Cooke, '82; J. S. Cooke, '79, Photos of locomotives.
H. F. Cunts, '94, Transverse tables in Pope Tube etc.
O. G. Dale, '93, Steam engine built in machine shop.
J. E. Denton, '75; D. S. Jacobus, '84, Apparatus for instruction in experimental mechanics.
R. M. Dixon, '81, R. R. car heating and lamps for lighting with Pintsch gas system.
J. A. Dixon, '91; Percy Allan, '95; Rudolph Bruckner, '96; J. V. Macdonald, '93; O. C. Whitney, '92, Associate engineers with R. M. Dixon.
Paul Doty, '88, Photos of gas works construction.
E. H. Foster, '84, Photo of triple expansion Worthington pumping engine.
A. F. Gans, '95, Polyphase induction motor.
N. H. Hiller, '89, Gage cocks and automatic valves for refrigerating machinery.
A. C. Humphreys, '81; A. G. Glasgow, '85, Photos of gas plants erected in various parts of the world by the firm of Humphreys & Glasgow.
Shirk Boyer, '90; L. D. Carroll, '84; F. N. Morton, '86; Joseph Norcross, '91; Wm. Randolph, '86; Rudolph Riege, '93; Fred Thuman, '90; W. H. Wade, '85; T. H. Van der Willigen, '88, Corps of engineers in the employ of Humphreys & Glasgow.
Dr. Geyer, '77, Artificial organic dye stuffs and materials for same.
G. C. Henning, '76, Precise instruments for testing materials.
Wm. Hewitt, '74, Samples of wire rope.
H. A. Hickok, '85, Centro linead.
George Hill, '81, Drawings and photos of buildings.
F. E. Jackson, '86, X-ray apparatus.
W. A. Jones, '94, Illust. description of slotting machine.
J. F. Kelly, '78, 40 K-W. induction generator and electric measuring instruments.
Wm. Kent, '76, Dynamometer, Torsion balance, books and album of papers and patents.
Wm. R. King, '86, Experimental electric furnace.
R. T. Kingsford, '96; W. H. McGregor, '96, Continuous indicator recorder.
J. B. Ladd, '81, Photos of blast furnace and steel works.
J. W. Lieb, Jr., '80, Photos of electric lighting and railway system of Milan, Italy.
A. M. Lozier, '94, Model of sounding apparatus.
W. O. Ludlow, '92, Photos and plans of buildings erected by Ludlow & Valentine.
L. H. Nash, '77, 20 HP. gas engine, water meters and sectional models.
W. E. Parsons, '87, Photos and drawings of cotton compressors.
O. F. Pfordte, '85, Samples of concentrated ores, photos of mining regions in Peru and Colorado.
W. D. Pierson, '94, Redesigned continuous wire drawing machine of Waterbury Machine Co.
Henry W. Post, '74, Plans of steel construction for buildings.
H. S. Prentiss, '84, Calendar clocks and automatic time switch.
W. E. Quimby, '87, Screw pump.
H. R. Rice, '85, Photos of engines of the Rice & Sargent Co.
E. P. Roberts, '77, Photos and drawing of electrical and power plants.
G. J. Roberts, '84, Model of water gas plant, with improvements, as manuf'd by the United Gas Impt. Co.
L. Ruprecht, '94, Specimens of Babbitt metals.
James E. Sague, '83, Photos of locomotives.
A. Schlesinger, '87, Rubber pump for corrosive liquids.
H. J. Schumaker, '94, Kites for experimental purposes.
H. R. Smith, '88, Illustrated description of magnetic elevator.
A. W. Stahl, '76, Paintings of U. S. S. Olympia. Photographic albums of U. S. S. Monterey and Oregon. Construction superintended.
H. Torrance, Jr., '90, Drawings of grain dryer.
E. A. Uehling, '77, Pneumatic pyrometer and gas composimeter.
F. Uhlenhaut, '88, Photos of Philadelphia Traction Co.
E. L. Vail (Artist), '76, Etchings and photos of original paintings.
J. Van Vleck, '84, Photos and models of steam engine and measuring instruments.
H. A. Wagner, '87, Motors, transformers, switches and electrical instruments.
J. T. Westcott, '90, Photos of Birmingham gas works.
Wm. Whigham, '88, Drawings of water spray apparatus for tempering armor plates.
A. R. Whitney, Jr., '90, Photos of wire nail plant.
L. D. Wildman, '90, Photos of original drawings of air compressors.
E. J. Willis, '88, Planimeter.
A. R. Wolff, '76, Plans for power, heating and ventilation, Astor Hotel, 34th St. and 5th Ave., N. Y. city.
F. H. Wood, '93, Photos of house. Original design.
D. Woodman, '80, Samples, of irons, steels, etc., with analyses.
A. J. Wurts, '84, Lightning arresters, cut-outs, etc.
Jos. Wetzler, '82, Books and edited volumes of "Electrical Engineer."

The list of things exhibited by the alumni, large as it is, nor the exhibition itself by no means gives a complete view of the many kinds of work done by the alumni. There are many graduates whose names do not appear on the list who have done work equally as meritorious as that of those listed. There are superintendents of motive powers and master mechanics of railways, managers of steel works and other factories, professors of enineering, patent lawyers, and men holding subordinate positions, whose work is not of a kind that can be shown in an exhibition.

The dinner at the Waldorf Hotel was a memorable event. For an hour before sitting down at the table there was a reunion of alumni and pro-

fessors, some of whom had not met in many years. The principal speaker after the dinner was Hon. Abram S. Hewitt, of New York, who made a most entertaining speech, giving his reminiscences of the Stevens family which dated back to nearly 70 years ago. He believes he is one of few men living who knew the elder John Stevens, and he told many amusing incidents in the life of his sons. Other excellent speeches were made by the Rt. Rev. Bishop Potter, Mr. Andrew Carnegie, Commodore Geo. W. Melville, Engineer-in-Chief of the U. S. Navy, and Prof. J. Elfreth Watkins, of the Smithsonian Institute. President Morton most happily responded to the toasts of "The Faculty" and also read an original poem, entitled "Per Aspera ad Astra," the motto of the Stevens family. This poem, with numerous historical notes relating to subjects mentioned in it, was printed in a handsomely illustrated and decorated pamphlet, which was presented by President Morton to each guest as a souvenir of the occasion. We quote the following lines commemorative of the deeds of the Stevens family:

The rapid steamer joining strand to strand
The yet more rapid train across the land;
The iron rail on which the swift trains run;
The shell adapted to the long range gun;
The iron-clad steamer ramming down the foe
With monster cannon loaded from below,
Those links which bind the world with bands of peace,
Those arms which in the end will make wars cease,
All these and many others which have lent
So largely to the world's development,
Grew from the Stevens lives, so richly fraught
With liberal outlay and ingenious thought.

The account of the dinner, with the speeches, will be printed in permanent form in the next issue of the "Stevens Indicator," the quarterly technical magazine published by the Alumni Association, and a complete account of the whole celebration, with the history of the Institute and of the work of the alumni, will be published in a few months by President Morton in the shape of a handsomely illustrated souvenir volume.

NOTES ON THE WATER SUPPLY OF DENVER, COLO.

During a visit to Denver last summer a member of the staff of this journal had the pleasure of inspecting some of the interesting parts of the water supply system, and collected a considerable amount of information relative to this system. After putting the matter in shape it was submitted to Mr. C. P. Allen, Chief Engineer of the Denver Union Water Co., in order to have it correct and complete, and we are also indebted to Mr. Allen for blue prints from which we have prepared the accompanying cuts of the new masonry dam. Some general notes on the waterworks were given in the "Notes of a Transcontinental Trip," in our issue of Sept. 3.

The original water-works were built in 1872 by the Denver Water Co., and were conducted by this corporation until 1889, when, owing to a disagreement, some of the stockholders withdrew and formed what was known as the Citizen's Water Co., the old company being then reorganized under the name of the American Water Co., and carrying on business until 1894, when the Citizen's Water Co. gained control, and the various systems were consolidated under the name of the Denver Union Water Co., which at present has the sole control of the water supply of Denver. The engineering department is in charge of Mr. C. P. Allen, who has for 20 years been connected with the water supply of Denver, and he is ably assisted by Mr. D. G. Thomas, his principal assistant, who has been connected with the company for over ten years.

The main supply of water is obtained by gravity from the Platte River, at a point about 20 miles from the city, to which it is conducted through a 30-in. and 36-in. wooden pipe. The present supply amounts to about 40,000,000 gallons per day, while an additional supply of 3,000,000 gallons per day is obtained from Cherry Creek, but this is a little uncertain, as the flow is subject to very rapid changes, due to mountain storms. There are now in operation three pumping stations, with a capacity of 30,000,000 gallons per day. These stations are fitted mainly with Holly engines, some of which are worked by water power, and others by steam, while some can be operated by either steam or water power. It is expected, however, that on completion of the present extension of the gravity supply, which will be in about two years, all pumping will be done away with, except for two high-service districts, the pumping plants for which will have a capacity of 2,000,000 and 6,000,000 gallons per day, respectively.

The company is now carrying out improvements that will cost about $1,000,000, of which $500,000 will be for a masonry dam, located at the South Fork of the South Platte River, a distance of 48 miles from Denver.

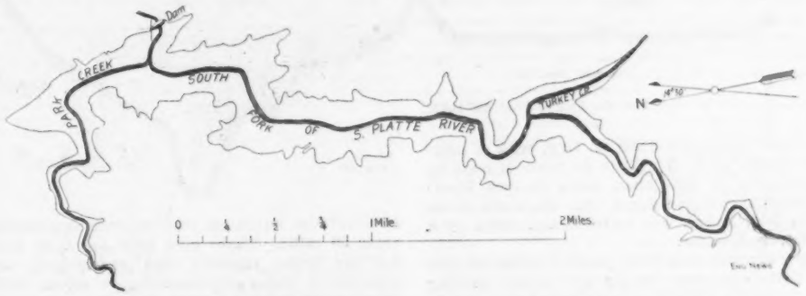


FIG. 1.—PLAN OF NEW RESERVOIR FOR THE WATER SUPPLY OF DENVER, COLO.

This dam is to be built in a narrow canyon, the ends being embedded in the solid rock walls of the canyon, and it will be constructed of granite obtained from the adjacent hill sides. The elevation will be very singular, the length at the bottom will be only 20 ft., increasing to 80 ft. at a height of 150 ft., while at the top the length becomes 400 ft., this being at an elevation of 200 ft. from the base. The dam will contain about 60,000 cu. yds. of masonry. Its site is on a government timber reservation, and when completed it will store 22,000,000,000 gallons of water. It will be built by day labor, and its outlet will be a 500-ft. tunnel, which is now being driven. This will permit of the water being discharged into the present river course, down which it will flow for a distance of 27 miles to the intake of the present conduit. Fig. 1 is a plan showing the location of the dam and the peculiar form of outline of the reservoir which will be formed by the dam, the water being backed up in a narrow valley or canyon. Fig. 2 is a contour map of the dam and its site, showing also the tunnel by which the water will be taken from the reservoir and discharged into the river channel below the dam, along which it will flow to the intake of the present conduit. Fig. 3 is a front elevation of the dam, and Fig. 4 a diagrammatic elevation showing the dimensions and form to which the rock slopes of the abutting mountain sides will be taken out. Fig. 5 is a cross-section of the dam, showing the lines of resistance with the reservoir full and empty.

The present conduit, above referred to, is made of the Allen wooden stave pipe, patented by Mr. C. P. Allen, the engineer of the water company. The pipe is laid about 50 ft. below the hydraulic grade lines so as to ensure its always being full, and under pressure, thus keeping the staves saturated. The staves are of redwood and pine, and the number of steel bands per 100 ft. of pipe is proportioned to the pressure. The conduit is in many places close to the surface as frost only penetrates from 18 to 24 ins., following the contour of the ground and keeping mainly alongside the public roads, while in one place it is laid under the bed of a stream. Where the location was such that if laid near the surface the conduit would be above the hydraulic grade line the ground is tunneled, the tunnel being lined with concrete, well rammed, finished smooth, and then painted with a thin coat of neat cement. The ends of the pipe conduit enter the tunnel and are covered with concrete and tightly banded, so that the staves swell against the solid concrete when wet and thus there is no leakage at the joints. The frictional resistance of the water in the tunnel is considerably greater than in the wooden pipe, and this, of course reduces the capacity. When this work was planned the question of capacity was given a thorough investigation, and from the limited information available it was decided to have 38-in. tunnels on the 34-in. pipe. Experience has proved that this is not enough,

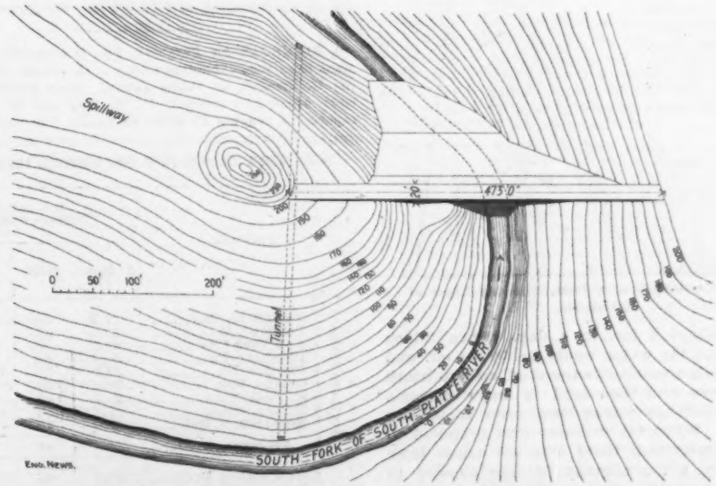


FIG. 2.—CONTOUR MAP OF DAM SITE, SHOWING OUTLET TUNNEL.

the water backing up at the tunnel, and it has been found that the diameter of the tunnels should have been 41 ins. On the 30-in. wood pipe line the tunnels are 36 ins. diameter, and this is about the right size, as there is no backing up of the water. The wood pipe is very easy to lay. In one place a pocket of quicksand was encountered which could not be trenched and the pipe line was therefore bowed out through a field, so as to pass the spot. No steel or wrought-iron pipes are used, as the alkali in the soil would corrode them.

The Marston Lake distributing reservoir is

formed by a natural depression and is located 9 miles from the city. It is a supplement to the direct supply in case of low water in the river, and has a present capacity of 2,500,000,000 gallons, but improvements are in progress that will increase its capacity to 5,500,000,000 gallons. These improvements consist of building earth banks at each end of the lake. There will be

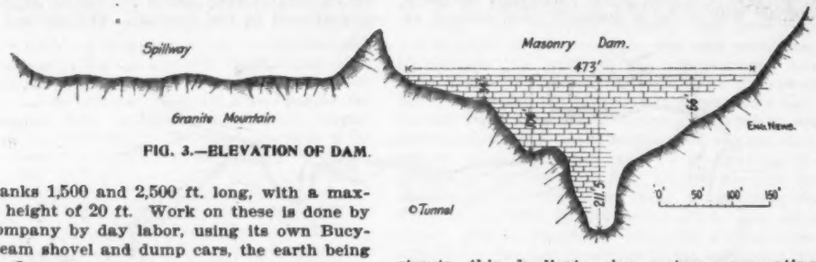


FIG. 3.—ELEVATION OF DAM.

two banks 1,500 and 2,500 ft. long, with a maximum height of 20 ft. Work on these is done by the company by day labor, using its own Bucyrus steam shovel and dump cars, the earth being laid in 6-in. layers, well watered and rolled by a 15-ton steam roller.

Below the lake is a filter plant of 9,000,000 gallons daily capacity, having the Allen gravity sand filters, but this is to be enlarged to a capacity of 16,000,000 gallons. The building has a wooden frame and corrugated iron covering, and contains twelve filters; of these ten are circular, 12 ft. diameter and 14 ft. deep, while two are rectangular, 12×40 ft., and 10 ft. deep. At the bottom of each filter is a layer of about 3½ ft. of sand or fine crushed quartz. A little chemical coagulant (sulphate of alumina) is sometimes, but not always used, the chemical being introduced at the head of the supply pipe. Beyond the filter plant again is a Venturi meter, with automatic electric recording gages, the meter and gages having been built by the Builders' Iron Foundry, of Providence, R. I. Here, too, is a curious by-pass arrangement, which we have already illustrated.

The two high-service distributing reservoirs were formerly open and great trouble was experienced from the algae growths, as the water is what is known as "white water" (practically colorless) through which the sunlight easily penetrates, and the algae grow rapidly from the bot-

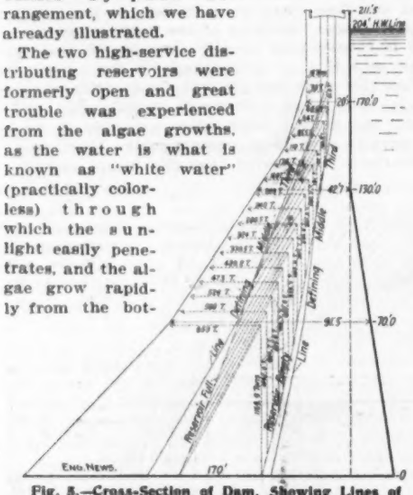


Fig. 5.—Cross-Section of Dam, Showing Lines of Resistance.

tom, sometimes 6 ins. in a day. When things got very bad the water would be drawn off, and men with forks would pile the stuff up into heaps like haycocks and then load it upon wagons, from 90 to 100 hay wagon loads being sometimes taken out. When the engineer first proposed to cover the reservoirs there was not much faith in the plan, but eventually he was allowed to cover a part of one reservoir. The algae growths then stopped as though cut off at the line of the covering, and the result was so convincing that Mr. Allen was then allowed to cover both reservoirs entirely. The covering is of planks and joists carried by vertical posts, and there is now no trouble from the algae.

The company owns several water rights on the river, but in order to keep them it has to use the amount of water to which it is entitled; otherwise somebody else may use the water and establish an intervening right. When the water is not required for the city it is therefore used on the ranches which the company has purchased for their water rights, these ranches being kept in cultivation and supplying hay for the company's large equipment of horses. The company has a large outfit of horses, wagons, machinery, etc., including also dump cars and a steam roller.

The distributing mains of the company are laid in every department of the city, affording a plentiful supply to both hydrants and consumers. Both of the old companies laid mains in the same streets, this duplicate pipe system aggregating some 50 miles. These pipe lines are both used, but are being renewed and rearranged, and coupled at street intersections to afford additional capacity for future use. The system as at present constituted has a capacity for 300,000 inhabitants, and when the present improvements are completed this will be increased threefold, and Denver will possess a water supply that is plentiful, pure and wholesome, while the plant is up to date, and in good condition.

PNEUMATIC TUBES FOR MAIL CARRYING in New York are proposed by Postmaster-General Wilson. The tubes are to be laid from the General Post Office along Third Ave. and Eighth Ave. to Harlem, where they would meet to form a complete circuit. The first part of the line will extend to the Grand Central Station to facilitate the handling of the railway mails. The senate committee on post offices and post roads will introduce a bill authorizing an appropriation of $150,000 for this purpose.

A FIREBOAT for Pittsburg, Pa., is proposed, and the plans have been submitted to Mr. J. O. Brown, Director of the Department of Public Safety. They provide for a stern wheel iron steamer, 152 ft. long and 30 ft. beam, capable of running 18 miles an hour. The cost is estimated at $45,000. It will be provided with two engines, each with a cylinder 20 × 27 ins., and there will be four boilers, 28 ft. long, 40 ins. diameter. On the lower deck will be six pumps, each with a capacity of 1,500 gallons a minute. These will connect with 20 nozzles on the upper deck, arranged forward of the pilot house and along the side of the cabin. They will be used in the case of burning steamers, which can be dragged out into the river and brought beside the fireboat. The pumps will also be connected with a 12-in. pipe extending from the side of the vessel. This is intended for connection with a line of pipe to be laid along the wharf, which, in case of fire within three or four blocks of the river, will afford a plentiful supply of water. At the forward end of the main deck, a hose reel, carrying 1,500 ft. of hose, will be placed for use in fires occurring along the wharf. The boat is intended to be used as an ice breaker, is to be built with a long rake forward, and of heavy material in this part, so as to break ice by pressure. The whole weight of the boat will be about 575 tons. The height from the keel to the top of the pilot-house, will be 26 ft. Deducting a 30-in. draft the highest point will be only 23½ ft. above the water, which will allow a passage beneath the lowest bridge during high water.

COMPETITION OF GAS COMPANIES IN KANSAS City, Mo., has resulted as such competition practically always does, in the consolidation of the two companies. The council has authorized the consolidation, over the mayor's veto, by a vote of 8 to 2 in each branch.

A NEW WAVE MOTOR, invented by Mr. Morley Fletcher, civil engineer, of London, has recently been experimented with in Dover harbor, it is said, with encouraging results. A floating buoy as it rises and falls with the waves operates the plungers of two pumps placed beneath it, the stroke varying with the size of the waves from one inch to four feet. The water thus pumped under high pressure is conveyed ashore by pipes and can then be utilized in running a water wheel or hydraulic motor. A buoy 4 ft. in diameter is said to have developed 3.7 HP. under favorable circumstances, but the effect is only trifling when there is a calm.

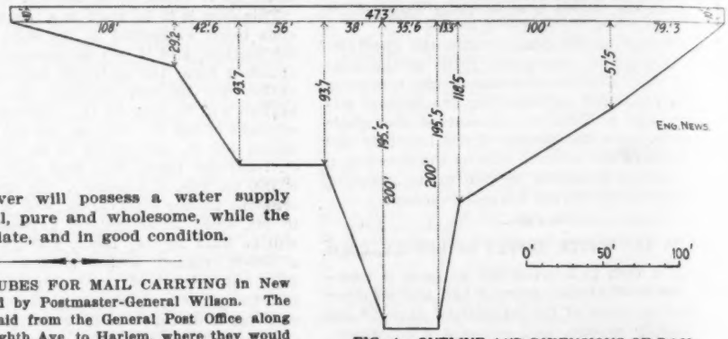


FIG. 4.—OUTLINE AND DIMENSIONS OF DAM.

WEATHER TABLE FOR DECEMBER, 1896. (Furnished to Engineering News by the Department of Agriculture.

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation—rain or melted snow—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average.	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	17.9	50	−10	60	8.4	44	NW	0.81	.64	6
	Portland, Me.	25.2	47	3	44	7.8	32	N	2.18	1.15	7
	New York City	32.1	85	5	50	14.5	54	N	1.70	.88	4
	Pittsburg, Pa.	35.2	60	11	49	6.4	20	SW	1.37	.60	11
	Chicago, Ill.	32.9	57	8	49	16.0	47	S	.16	.06	5
	Omaha, Neb.	35.2	56	10	46	6.7	26	SW	.50	.32	3
	St. Paul, Minn.	23.3	45	−9	54	6 3	23	NW	.71	.22	8
	Duluth, Minn.	21.8	46	−21	67	8.6	40	N	.84	.24	13
	Bismarck, N. Dak.	19.0	46	−23	69	6.5	29	S	.03	.01	3
	Average.	27.0	51	−3	54	9.0	35		.92	.46	7
Southern Cities.	Washington, D. C.	35.6	66	12	54	6.7	34	NW	.30	.18	5
	Louisville, Ky.	41.0	66	15	51	8.7	27	SW	2.15	1.23	5
	St. Louis, Mo.	40.8	68	17	51	10.2	30	SW	1.05	.94	4
	Savannah, Ga	49 8	72	28	44	5.8	27	NW	6.86	3.93	8
	Kansas City, Mo.	40.4	67	17	50	7.7	28	SW	0 71	0.35	4
	Jacksonville, Fla.	53.8	74	34	40	6.9	28	NW	2.17	.90	8
	Chattanooga, Tenn.	43 7	69	19	50	6 6	31	NW	0.83	.48	5
	New Orleans, La.	54.5	78	32	46	9 6	24	SW	3 77	1.85	10
	Memphis, Tenn.	46.8	73	21	52	9.4	30	W	0 56	.43	4
	Palestine, Tex.	53.0	80	23	57	6.3	27	SE	2 15	1 18	4
	Average.	45 9	71	22	50	7.8	29		2.06	1.15	6
Western Cities.	Helena, Mont.	35.9	55	6	49	5.9	50	SW	0.35	.21	5
	Port Angeles, Wash.	42.5	57	32	25	4.4	30	SW	6.65	1.10	26
	San Francisco, Cal.	52.8	64	42	22	7.7	36	SE	4.34	1.65	11
	Salt Lake City, Utah.	36 2	54	17	37	4.4	26	SW	0.84	.29	6
	Santa Fe, N. Mex.	35 8	57	18	39	5.8	24	SE	0.67	.64	2
	Denver, Colo.	38.8	68	18	50	7.6	36	W	0.31	.30	2
	Yuma, Ariz.	58.6	78	41	37	6 2	34	NW	0.78	.73	2
	Average.	42.9	62	25	37	6.0	34		1.99	.70	8

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The 27th annual convention of the Institute held at Chicago, Ill., Feb. 16, 17 and 18, 1897, while not largely attended proved very successful both in the character of the papers and discussions presented and the various provisions for social intercourse. About 50 members were in regular attendance at the different sessions and with visitors and guests the total attendance probably numbered about one hundred. As usual, considerable time was given to excursions to various points of interest by the whole body of members and in addition many individual members made visits to various of Chicago's manufacturing establishments from which invitations had been received. Among the formal excursions may be mentioned those to the Field Columbian Museum, to the Burnside shops of the Illinois Central Ry., and to the South Chicago works of the Illinois Steel Co. On the evening of Feb. 17 a reception to the members was given by the Technical Club of Chicago and on the following evening the regular banquet was held at the Auditorium Hotel. Both of these entertainments were attended by the majority of the members present at the convention.

At the opening session, held on the evening of Feb. 16, the time was devoted to the reading of memoirs of deceased members, the presentation of a paper descriptive of the Chicago Main Drainage Channel, and the usual addresses of welcome and extension of courtesies by various local engineering organizations and industrial establishments. The paper on the Drainage Canal, by Mr. Jas. F. Lewis, of Chicago, was a somewhat off-hand exposition of the character and purpose of this great work and a description of the methods of accomplishing it, and was fully illustrated by stereopticon views provided by the engineers of the canal. The canal work is already familiar to the readers of Engineering News and no further mention need be made of Mr. Lewis' paper.

Wednesday's Sessions.

The real technical work of the convention was begun at the opening session on Wednesday morning and during this and the afternoon session five formal papers were read and discussed and a number of discussions were presented on the paper of Dr. Albert Sauveur, "The Microstructure of Steel and Current Theories of Hardening," read at the Denver, Colo., meeting in September, 1896. These last discussions were of a very technical character and were mostly written, which together with the character of the subject make any satisfactory abstract here impossible. The whole discussion, which ranks as an unusually authoritative consideration of this important question, will, of course, be published in the transactions of the Institute and can be studied there.

The first paper presented at the Wednesday morning session was by Messrs. N. W. Lord and F. Haas, of Columbus, O., entitled "The Calorific Value of Certain Coals as Determined by The Mahler Calorimeter." Several points of general interest were brought out in the paper together with valuable analyses of a number of coals much used for generating steam, and an abstract of these features will be presented in a future issue. There was no discussion and the paper next following was by Messrs. Howard W. Du Bois and Charles S. Mixer, of Philadelphia, Pa., entitled, "Note on the Determination of Insoluble Phosphorus in Iron Ores." This paper was presented in abstract by the Secretary and no printed copies being available for examination there was no discussion. In brief the paper described the work of the authors to obtain a simple and reliable method of determining the amount of insoluble phosphorus in iron and gave in detail the methods and results of the various experiments made by them. Broadly stated the final method evolved consisted first in the solution of the iron and then ignition of the residue in the usual manner. Following this paper came one of somewhat more bearing on mechanical than upon mining engineering, it being entitled "Analysis of Waters of Illinois," by J. A. Carney, of Aurora, Ill., the analyses having been made to determine the relative value of surface, ground and deep well waters along certain lines of the Chicago, Burlington & Quincy R. R. in Illinois for steam making purposes, particularly in locomotive boilers. The paper was read in abstract from the manuscript, no printed copies being available for distribution. Summarized briefly, the various analyses showed that of the different local waters tested those from the surface were best for boiler use and the deep well waters were the poorest.

The concluding paper of the morning session was by Prof. F. W. Denton, of Minneapolis, Minn., University of Minnesota, and was entitled "Mining Methods in Northern Minnesota." Prof. Denton presented his paper in abstract and illustrated it with stereopticon views, showing the various methods of surface and underground working of iron mines in both the Mesaba and Gogebic ranges. As indicated by the title the paper dealt exclusively with methods of mining, and it was notable for presenting a vast amount of practical information regarding the methods of operation in a mining region concerning which very little such information has hitherto been published. The character of the paper was such as practically to preclude discussion.

At the opening of the Wednesday afternoon session Mr. Axel Sahlin, of Sparrows Point, Md., presented a paper entitled "The Handling of Material at Blast Furnaces," partly historical in character, which traced briefly the development and described in detail the latest mechanical contrivances used in charging blast furnaces and handling the pig and slag at the bottom. The value and clearness of the paper depended largely upon the illustrations accompanying it and as these are not yet available for use it can not be even summarized here. Following this paper Mr. Robt. W. Hunt, of Chicago, Ill., read the following brief appendix to his paper on specifications for steel rails presented at the Atlanta meeting.

At the Atlanta meeting of the Institute, Oct., 1895, I had the honor of presenting a paper on "Specifications for Steel Rails of Heavy Sections Manufactured West of the Alleghenies." In it, reasoning from the experience of Western railroads with heavier sectioned steel rails, I called attention to the importance of the chemical composition of the steel, and urged the increase of the carbon percentage, and the limiting of phosphorus to the lowest point reconciliable with commercial considerations—and also insisted on the value of added silicon.

My paper has been honored by the favorable consideration of a number of the engineers and other controlling officers of western roads, and it resulted in over 186,000 gross tons of rails of sections heavier than 65 lbs. per yard being manufactured since that time in accordance with my views. These rails are in the tracks of several large railway systems. In giving the above tonnage I refer only to the rails which came under my immediate supervision; that is, under the inspection of my firm.

Over 60,000 tons were 80 lbs. to the yard.

In some cases it was not commercially possible to obtain quite as low a percentage of phosphorus, as desired, and hence the carbon was reduced proportionately, but, as a whole, the rails could be classed as high carbon ones. Of course, it is too soon to form a positive opinion in relation to the wear of the rails—but practically all of them have been in service long enough to demonstrate their safety, and I believe in all cases the users of the rails unite in the opinion that so far they promise much better wearing results than previously obtained; and I know in several instances, based on such showing, still harder steel will be insisted upon in this year's deliveries.

I present this short article somewhat in the nature of a "report of progress." Moreover, in view of the recent somewhat surprising developments in the American rail trade, it is well not to lose sight of the necessity of not permitting low prices to be the only consideration. The first cost of rails is not all the story. This does not require discussion. If it is necessary to pay a little more for a good rail—true economy speaks in no uncertain voice in favor of so doing. Low prices are very attractive, but subsequent economies in track maintenance, repairs to rolling stock, possibilities of high speed, and comfort of passengers must not be ignored.

The peculiarities of human nature must be remembered. They do not change very much. When articles are sold at a low price those in direct charge of the manufacture of them will, most likely, be expected to keep cost of production down to a corresponding degree. This may lead to temptation to cut some corners, which had better have remained in full projection. At all events it does not seem wise to ignore past experience in steel rail metallurgy.

The next business following was the discussion on Dr. Sauveur's paper, before mentioned. Some of the members presenting written or oral discussions were Mr. F. Osmond, of Paris, France; Henry M. Howe, Boston, Mass.; Prof. A. Ledebur, Freiberg, Saxony; R. A. Hadfield, Sheffield, England, and half a dozen others equally well known as authorities on the subject. Altogether the paper and its discussions rank among the foremost in value of any ever presented to the Institute, and those interested can hardly do better for a resume of the various theories put forth to account for the hardening of steel than to obtain the full proceedings.

Thursday's Session.

At the fourth session on Thursday morning the reading and discussion of papers were continued with the paper on "The Distribution of the Precious Metals and Impurities in Copper and Suggestions for a Rational Method of Sampling," by Edward Keller, of Baltimore, Md. The paper called attention to the ordinary method of sampling copper by assaying samples taken from the bars or pigs, and noted that it failed to be a fair indication for the reason that the precious metals were not uniformly distributed or in other words that the mixture was not homogeneous. Numerous tests made by the author showed that the concentration or segregation of the precious metals took place sometimes toward the center of the pig and sometimes from the center toward the outer surfaces. The author stated the facts as follows:

The results thus obtained clearly prove the existence of two classes of copper-alloys. As already pointed out, in one class the foreign elements concentrate towards the center of solidification; in the other the copper concentrates to the center, while the foreign elements appear to have concentrated towards the outside. Not a single element tested for has remained homogeneously distributed, but the degree of uneven distribution varies with each one.

With reference to the practical question of sampling, we must draw from the indubitable facts stated the conclusion that it is almost impossible to obtain, from bars and pigs of the usual unsuitable dimensions, by drilling, punching or chipping samples of satisfactory accuracy. As we have seen, concentration takes place from or towards every surface. Hence, in such bodies of metal, what might appropriately be called a core is formed in the center, which is enriched or impoverished, as the case may be, and which does not conform in shape to the outer surface. It is for this reason so difficult to obtain aliquot parts of the different portions of a bar or pig. The root, then, of the difficulties of sampling, so often complained of, lies in the irrational shape into which the various metals are cast.

To eliminate all the difficulties inherent to pigs and bars, as above described, we only need to reduce one dimension; or in other words, to cast a plate, the thickness of which is small compared to the other two dimensions. Of course, concentration in this plate is governed by the same law as in any other body; it takes place from or toward the center. But the concentration in the horizontal direction, from the sides, can extend no farther than a distance equal to the thickness of the plate, for when the solidification has proceeded that distance horizontally the plate has entirely solidified vertically. We thus have all around this plate a zone not wider than its thickness, where concentration has taken place just as in a bar or block; that is, both horizontally and vertically, and consequently we have one enriched and one impoverished band around the four sides. In the part of the plate enclosed by this zone we have had concentration in the vertical direction only, and the plate here consists, therefore, of what we may term layers of metal of different concentration. If we drill or punch through all of these layers we obtain a correct sample of the whole plate.

In a brief written discussion read by the Secretary, Mr. Albert R. Ledoux, of New York city, confirmed Mr. Keller's statements regarding the difficulty of securing reliable samples from pig copper for assay, and approved the plate casting recommended.

With the conclusion of this paper the Secretary read in abstract further discussions of Dr. Sauveur's paper and the time for adjournment having nearly approached, the remaining papers were read by title, after which the retiring President, Mr. E. G. Spilsbury, of Trenton, N. J., delivered his address. The theme of the address was the improvements made in the metallurgy and reduction of metals during the ten years just passed. Naturally the remarks were largely of a historical character. The chief points noted were that the improvements had been mostly in the general betterment of mechanical appliances rather than in any great discovery having been made. Of the various new forces which had been brought to the aid of the engineer, Mr. Spilsbury gave first place to electricity and was disposed to think that this force would continue in its present leading position for some years to come.

The papers read by title only were the following: "The Spitzkasten and Settling Tank," by R. H. Richards and C. E. Locke; "Sulphur in Embreville Pig Iron," by Guy R. Johnson; "The Precipitation of Gold by Zinc-Thread from Dilute and Foul Cyanide Solutions," by Alfred James, of Glasgow, Scotland; "The Geology of the Magnetites Near Port Henry, N. Y., and Especially Those of Mineville," by J. F. Kemp, and "The Manganese Deposits of the Department of Panama, Republic of Colombia," by Eduardo J. Chibas.

The ballot for officers for the ensuing year resulted in the election of the following: President, Dr. Thomas M. Drown, South Bethlehem, Pa.; Vice-Presidents, D. W. Brunton, Aspen, Colo.; W. E. C. Eustis, Boston, Mass.; James Douglas, New York; Managers, Charles W. Goodale, Butte, Mont.; Frank Lyman, Brooklyn, N. Y.; Frank McM. Stanton, Houghton, Mich.; Treasurer, Theo. D. Rand, New York, and Secretary, R. W. Raymond, New York. The total number of new members elected was 110.

BOOK REVIEWS.

BUILDING AND ENGINEERING TRADES DIRECTORY. —First edition, 1896-7. Boston: F. W. Dodge; 8vo; board; pp. 307; $2.

This directory contains the names and addresses of all New England architects and engineers; classified and indexed lists of the industries and trades identified with architectural and engineering interests in Boston and the metropolitan district; a list of the members of the Builders and Contractors' Association of Boston; and over 100 pages of advertisements.

PROTECTIVE COATINGS FOR IRON.—A chemical and physical examination of paints commonly used for the protection of iron against corrosion. By J. Spennrath, Director of the Technical School at Aix la Chapelle. Prize essay in a competition held under the auspices of the Society for the Advancement of the Industrial Arts. Translated from the German and published by the Railroad Car Journal, New York, 1896. Pamph., 6×9 ins.; pp. 40. 50 cts.

This essay describes a series of experiments on the rusting of iron and on the durability under corrosive influences of a number of oil and paint skins made by applying three coats of paint to thin zinc plates and then dissolving the zinc in dilute sulphuric acid which does not attack the skins. The whole subject of protective coatings for iron is discussed in a thorough and scientific manner, and we commend the pamphlet to the attention of all engineers who are interested in the preservation of iron structures from rust.

X RAYS.—By Edward P. Thompson, M. E., E. E., M. Am. Inst. E. E., M. Am. Soc. M. E. Last chapter by William B. Anthony, Past Pres. Am. Inst. E. E. New York. D. Van Nostrand Co. 8vo; cloth; pp. 190; 60 diagrams; 45 half tones; $1.50.

The work is written partly for the student and investigator and partly for the physician and surgeon. One of its features is a chapter on diagnosis and anatomy. This new form of energy for which there are two names, the Roentgen ray and X ray, is radiated from a highly exhausted vacuum tube, whose terminals are connected to the poles of an induction coil or any high voltage current producer. It has been supposed that X rays might be secured from other than electrical sources, but the author believes this a mistake.

The work is largely a compilation of experiments which have been described in the scentific and technical press, beginning with the historical experiments leading to the discovery of the X rays. A number of methods are given for obtaining results somewhat similar to those with X ray

apparatus; one method being to wrap the object, as a coin, in black paper and place it on the sensitive side of a photographic plate. A high tension current from a Holtz machine passed through the coin and plate gives a clearly defined image which is called an electrograph. Some sciagraphs, which correspond to photographs in photography, are reproduced to illustrate the ease with which pure diamonds may be sorted from imitations with the aid of X rays. The book has an extended table of contents, but there is no index whatever, an inexcusable defect in a scientific work. The press work is good and the illustrations are excellent.

GENERAL SPECIFICATIONS FOR STEEL ROOFS AND BUILDINGS. By Charles Evan Fowler, Assoc. M. Am. Soc. C. E. Third Edition. Revised 1897. Pamphlet, 8vo.; pp. 13. Published by the author at Youngstown, O., and sold by Engineering News Publishing Co. 25 cts.

In this edition Mr. Fowler has changed the form of his specification to an octavo pamphlet and has introduced a number of new features. Among them is an increase in wind loads for buildings over 20 ft. and up to 60 ft. high; unit stresses are changed to conform to the use of only one grade of steel and the use of iron is confined to bars; and figures are given for determining the size of ventilators for shops of various classes. Coefficients are also given for the calculation of stresses in four different kinds of trusses and for three different pitches, with the general formulas for the same. The book closes with tables of column units, stresses and rivet values, and details of corrugated iron connections, flashing and louvres.

THE ELEMENTS OF PHYSICS.—A college text-book by Edward L. Nichols and William S. Franklin. In three volumes. Vol. II. Electricity and Magnetism. New York, the Macmillan Co. 8vo; cloth; pp. 272. illustrated. $1.50.

The authors of this work are professors of physics at Cornell University, and at the Iowa Agricultural College, respectively. The first volume, on Mechanics and Heat, has already been reviewed in these columns, and the third, on Sound and Light, is yet to be published. All of these text-books are written upon the assumption that the student is well grounded in the higher mathematics. The opening sentence reads: "A distributed scalar is a scalar quantity used to specify the condition or state of a medium." Further paragraphs define "The volume integral of a distributed scalar," "A distributed vector," "Solenoidal vector distribution," etc. It is proposed that the text shall be used in connection with illustrated lectures.

Notwithstanding the impression that the reader gets from the opening chapter, the majority of the mathematical demonstrations involve only algebra or, at the most, rudimentary calculus. All the well-known methods of measuring small currents of electricity are discussed with descriptions and illustrations of the apparatus employed.

The subject of static electricity occupies 168 pages, and under this head is a very short discussion of the Roentgen phenomena. It is stated that objects upon which cathode rays impinge give off the Roentgen rays, and are best generated by a piece of platinum placed at the centre of curvature of a cup-shaped cathode of a focusing tube. These rays pass through all substances more or less readily, are rendered visible by luminescent screens and affect the photographic plate. The principles involved in dynamo construction are considered in a single short chapter.

The chapter subjects in order are: distributed quantity, magnetism, the electric current, resistance and electromotive force, electrolysis and batteries, measurements, electro-statics, the electric field, electrostatic capacity, discharge, magnetism in iron, induction, thermo-electricity, practical applications, electric and magnetic units, and the electromagnetic theory of light, and mechanical conceptions of electricity and magnetism.

The illustrations are particularly good and the arrangement is excellent for class purposes.

We are inclined to seriously question, however, whether the introduction of so large an amount of mathematics into text-books on physics, will not hinder the average student from attaining a good practical knowledge of the science of physics, which is not only vastly more important than the mathematical portion; but is that science in which it is of the greatest practical importance that an engineer should be well grounded.

POWER DISTRIBUTION FOR ELECTRIC RAILROADS. —By Louis Bell, Ph. D., M. Am. Inst. E. E. Street Railway Publishing Co., 26 Cortlandt St., New York city. 8vo.; cloth; pp. 268; 139 drawings and illustrations; $2.50.

This book fills a long felt want in this branch of engineering; there have been many demands for such a work, and the well-known name of Dr. Bell is alone a guarantee of the excellence of its contents. The book discusses all classes of electric railways, the light cheap lines for country roads as well as the heaviest work for cities. The first chapter deals with the fundamental formulas of distribution and the size of conductors, with the accompanying problems. The return circuit is the subject of the second chapter. The necessity of thorough rail bonding is especially emphasized; the conductivity of the rails of the average street railway system is many times that of the trolley wire and yet the fact is notorious that track bonding is so nearly worthless in many cities that the current leaves the rails to return along gas and water pipes and other metal conduits, resulting in their gradual destruction. The author considers the welded joint the only absolute solution of the problem of bonding, but refers to the plastic bond as a promising system. The double trolley may be of service on straight lines, but for ordinary city work the mechanical difficulties in the way of installing and keeping up the overhead system of frogs, crossings and the like are formidable.

The computation and arrangement of feeders, boosters, the three-wire system, sub-stations, transformers, transmission lines, insulators, synchronous motors, polyphase generators and the operation of machines are a few of the many subjects taken up.

One chapter is devoted to alternating-currents in railway work. Quoting from the beginning of this chapter:

A vast amount of money, time and ingenuity has been spent in attempts to develop motors for alternating-currents good enough to replace continuous current motors. These attempts have led to many failures, but we have come at the present time to a very gratifying measure of success.

With the installation of alternating currents in street railway work the problem of electrolysis of underground pipes will be solved.

The last chapter deals with fast and heavy railway service, describing several roads now in operation, such as the Baltimore & Ohio tunnel railway, the Nantasket Beach branch of the New York, New Haven & Hartford Ry. and the Chicago Lake St. Elevated. Among the subtopics under this head are: Track for extremely high speed, the third-rail system, air and other resistances, the braking problem and cost of power.

The book is thoroughly practical; the mathematics which it contains are easily understood; there are no endless pages of formulas and confusing symbols so disheartening to the student who is not a born mathematician. This last fact alone, proving as it does that a mass of "mathematical rubbish" is superfluous, must commend it to the engineer who has real problems to deal with and has no time for theoretical nonsense.

The press work has been well done and the illustrations are excellent.

THE STRESSES IN FRAMED STRUCTURES, including the strength of materials and theory of flexure, also the determination of dimensions and designing of details, specifications, complete designs and working drawings. By A. Jay Du Bois, C. E., Ph. D., Professor of Civil Engineering in the Sheffield Scientific School of Yale University. Tenth Edition, rewritten and reset. New York, John Wiley & Sons. Imperial 8vo; pp. 617; many illustrations and folding plates; $10.00.

As Prof. Du Bois remarks in his preface, this is essentially a new work. The nomenclature and notations throughout have been made to conform with modern practice; some statements, found to be erroneous, have been eliminated and new and revised methods of treatment have been introduced. The changes to be especially noted are as follows: The use of new and corrected matter in the article upon graphic representation of moments by any number of forces; a revised treatment of the method of calculation by concentrated load systems, and by equivalent uniform load, and by one and two locomotive excess load with equivalent and actual uniform train load. This treatment compares results, but presents the matter in such shape that any method may be used. The principle of least work is here applied to swing bridges, to the braced arch and to the suspension system, giving new formulas and solutions. Prof. Du Bois shows that older formulas are but special cases of the more general method here proposed, where depth and chord sections are constant, and he points out the old error of assuming that in the suspension system the cable carries the entire load, with the truss simply distributing the loading. The chapter on the theory of flexures and mechanics of materials is more clearly written, again applying the principle of least work. The "ideal column" is newly treated, giving here the new formula developed by Mr. H. S. Prichard, M. Am. Soc. C. E., which Prof. Du Bois says is probably the most important contribution on this subject since the derivation of Euler's well-known formula. The formula of Prof. Merriman is also especially commended as the best practical formula so far proposed.

In the part dealing with practical designing and structural details the numerous changes to be noted are in line with present practice. But as bridge design is still in the developmental stage, the author does not attempt to keep pace with the detailed changes, but seeks rather to clearly present the permanent principles and practices upon which good design, of any date, must rest. This part contains the 1896 specifications for steel railway bridges, of Theodore Cooper, M. Am. Soc. C. E.; John Sterling Deans, M. Am. Soc. C. E., Chief Engineer of the Phoenix Bridge Company, has brought the chapter on erection up to the date of present practice, and Wm. W. Crehore, M. Am. Soc. C. E., has written a timely and excellent chapter upon high-building construction. The chapter on erection is undoubtedly the fullest, most practical and best illustrated ever published upon this subject, ranging in its treatment from falseworks for spans under 25 ft. to travellers for spans 84 ft. deep between centers of chords, and to falseworks for arches of 200 ft. span. Mr. Crehore, in discussing high buildings, describes the foundations; various systems of fireproofing floors and partitions; girders and columns employed; wind bracing, and the general design and calculation of stresses.

BERLIN UND SEINE BAUTEN.—Bearbeitet und herausgegeben vom Architekten-Verein zu Berlin und der Vereinigung Berliner Architekten, 1896. Wilhelm Ernst & Sohn, Berlin, Germany. 3 vols.; 4to; 80, 577 and 296 pp.; with 18 photogravures, 1 etching and 2,150 illustrations in the text, and 4 folding plates; unbound, 60 marks; bound in linen with leather corners and back, 72 marks.

This is a monumental work dedicated to the Emperor, William II., and issued in commemoration of the twelfth annual convention of the German Architectural and Engineering Societies. A somewhat similar work was published in 1876, but this issue is vastly extended to cover the progress of the last 20 years. Vol. I. commences with a historical sketch of the city of Berlin, treating also of its geology, climate and gradual territorial extensions, and giving statistical tables. This portion is illustrated with reproductions of old views of the city, plans, coats of arms, etc. The development of traffic comes next, with notices of the railway of 1839, cross-sections of streets, ancient and modern, parks and open spaces, etc. Illustrations and descriptions are given of the street furniture, such as hydrants, lamp-posts, street signs, letter-boxes, refuse-depositories and kiosks. In another chapter the public parks and gardens are further described and magnificently illustrated by half-tone cuts and by detailed plans. The bridging of the river Spree and its general rectification and control form the subject of several profusely illustrated chapters; showing the sections and designs of quay walls and dock apparatus and giving commercial statistics. The street-bridges are especially well treated, and the text and illustrations cover 90 of these structures, with a very considerable amount of constructive detail given with each. This part of the work is alone sufficiently valuable in its variety of design and detail to warrant its possession by the bridge designer. The bridges vary from plain plate-girders to the most elaborate structures of stone, with all degrees of ornamentation. Horse and electrical street railways are next taken up, illustrating the sections of rail used, track construction, stables, power-houses, cars, etc. Parts of the electrical system are of the ordinary trolley type and other portions are operated upon an elevated structure with side conduits. The steam railway stations and the elevated steam roads of Berlin are also fully treated in all their varying types of construction, nearly 200 pages of this quarto volume being devoted to this subject. Next comes the water supply of Berlin, with its history and statistics, basins, filters, pumping plant, station-houses and the dwellings of employees. Driven wells are largely used for some sections of the city. The sewerage of Berlin is described in detail, from the construction of the sewers to the operations of the completed system and the treatment of the sewage. The description of the gas works closes what may be classed as the engineering part of the work, so far as public works are concerned. The concluding chapters of Vol. I. relate to building materials, to structural methods adopted in the city, heating and lighting, domestic water supply and its fittings and the fire department. Other chapters describe the more prominent industrial establishments of Berlin.

The second and third volumes of this work are architectural in their scope, commencing with an illustrated description of the old and new palaces of Berlin, with their history, and reproductions from old prints and beautiful photogravures of those now in existence. The statues, fountains and monuments of the city follow, and then come the theatres and various public buildings, with their plans and elevations. The churches, with their monuments of great men, form another long chapter, followed by a description of the schools of Berlin, the hospitals, charitable institutions, markets, bath-houses, disinfecting establishments, etc. Hotels, beer and coffee houses have a chapter to themselves, followed by illustrations and descriptions of prominent mercantile establishments and the handsomer dwelling houses of Berlin and its suburbs. Of the whole book it may be said that we know of no previous work which has so completely and handsomely described and illustrated a great city in all its constructive detail. The half-tone views are to be especially commended for their sharpness and general excellence, and all of the thousands of illustrations are of the most artistic character. The 1,500 quarto pages of text contain the full statistical and general information that is to be expected from a coterie of painstaking German authors.

While few American engineers, and especially those who do not read German, will feel like purchasing such expensive works for their private libraries, we believe the value of the illustrations alone in these volumes is such that they should be secured for all public libraries which aim to keep abreast with the time in engineering literature. The librarians of engineering societies and engineering schools especially should not fail to secure them.